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ABSTRACT

This curriculum for a 1-semester or 1-year course in electronics is designed to take students from basic through advanced electronic systems. It covers several electronic areas, such as digital electronics, communication electronics, industrial process control, instrumentation, programmable controllers, and robotics. The guide contains competencies (task lists), student competency records, and management sheets. Management sheets, which serve as lesson outlines covering 1 or more days, include the following: an introduction, performance objective, task/competency statement, equipment and supplies list, a performance standard, suggested references for teacher and student, activities, and evaluation criteria. Some of the topics covered are as follows: analyzing electrical and electronic systems, analyzing electrical system components, analyzing DC electrical circuit operation and component functions, investigating the principles of magnetism, AC system and component analysis, diode devices, amplifying devices, electronic oscilloscopes, and electronic power control systems. Appendixes include a course outline, definitions of terms, course objectives, laboratory equipment, laboratory supplies, eight-item bibliography, and suggested facility layout. (KC)

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Curriculum Guide
for
Technology Education
Advanced Electronic Systems

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Developed by

Mr. Dale R. Patrick, Project Director/Writer
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for

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Office of Vocational Education

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1988

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An independent electricity/electronics textbook review committee approved Electricity and Electronics by Patrick and Fardo as a recommended text to be used with this course.

ACKNOWLEDGEMENTS

Appreciation is expressed to the following people for their contribution to the development of this competency-based electronic communication curriculum guide.

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INTRODUCTION

Electronics is a special branch of technology that deals with the movement of charged particles through matter. This branch of technology has gone through some of the most significant changes of the entire field. Such things as digital electronics, microprocessors, lasers, programmable controllers, robotics, and computers are largely responsible for these changes. Essentially, these changes have led to the development of special subdivisions of the electronics field. This is responsible for digital electronics, communication electronics, industrial electronics, power control, power technology, instrumentation, and industrial process control. Electronics is now considered to be a generic term that describes a number of separate branches or subdivisions.

Since electronics is a broad descriptive term that includes numerous branches and subdivisions, it is rather difficult to come up with a term that is all inclusive of its many divisions. The term "Advanced Electronics Systems" is used here to describe several of the electronic areas under one common heading. Advanced Electronics Systems is a curriculum that includes such technologies as digital electronics, communication electronics, industrial process control, instrumentation, programmable controllers, and robotics. This curriculum was designed as a one course offering. It can be used for one semester (18 weeks) or two semesters (36 weeks). An (*) will be used to denote those items to be included in the one semester offering.

Advanced Electronic Systems does not have a prerequsite and it is designed to take the student from basics through advanced electronic systems. The pace of this curriculum starts rather slowly with basics and moves rather rapidly through the advanced areas. Basic theory serves as a foundation for the more advanced areas of study.

The term system plays an important role in this curriculum. It serves as a key concept for the entire curriculum. A system is first described as a complete functioning unit that achieves some form of work. It has essential parts or blocks that are needed to make the system operational. Each block plays a significant role in the operation of the overall system. Specific blocks are further divided into discrete components and presented in more detail. Through this approach, the student will be able to envision a composite of a specific system, see its fundamental parts, and realize the role that these parts play in the operation of a functioning system. This method of presentation is often associated with the gestalt or "big picture," approach in the psychology of learning.

Content of the Advanced Electronic Systems curriculum is technologically oriented. It is intended to acquaint the student with material that will be of value in making a career decision. The demand for personnel trained in this area is almost overwhelming today. Both male and female students should feel comfortable in this curriculum. It brings together learning from other courses such as business, science, and mathematics. The material of this curriculum incorporates problem solving, design and planning, graphic communication, materials and processes, manipulative activities, cognitive skills, and an appreciation of the role of industry. This curriculum is popular, self motivating, and extremely rewarding for the student. As a rule, the teacher should serve as a coordinator or director of the activties. The student must read about the subject, take part in the presentation of this material and eventually do some manipulative activity that solidifies the content in a meaningful learning experience.

Dale R. Patrick
Eastern Kentucky University
Richmond, KY 40475

ADVANCED ELECTRONIC SYSTEMS

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ADVANCED ELECTRONIC SYSTEMS

COMPETENCY LIST

*Used for 18-week course.

Analyzing Electrical and Electronic Systems

*AES-001. Define Electrical System Parts.

*AES-002. Describe the operation of a flashlight.

*AES-003. Examine the structure of matter, static electricity, and the laws of attraction and repulsion.

*AES-004. Solder electrical conductors and measure their size.

*AES-005. Discuss the rules of electrical safety.

Analyzing Electrical System Components

*AES-006. Draw the components of an electrical system with symbols to form a schematic diagram.

*AES-007. Determine the value of resistors by color code and measure resistance with an ohmmeter.

*AES-008. Measure DC voltage and current with a single function meter and a multifunction meter or VOM.

Analyzing DC Electrical Circuit Operation and Component Functions

*AES-009. Build a simple DC electric circuit and define the relationship between V, I, R, and W.

*AES-010. Construct a series DC circuit and evaluate the V, I, R, and W.

*AES-011. Construct a parallel DC circuit and evaluate the V, I, R, and W.

*AES-012. Construct a combination circuit and evaluate the V, I, R, and W.

*AES-013. Determine component values of a circuit by calculation.

Investigate the Principles of Permanent Magnetism and Electromagnetism

AES-014. Develop a field diagram of a bar magnet.

AES-105. Magnetize and demagnetize an iron bar.

AES-016. Build an electromagnet and evaluate the operation of an electromagnet.

AES-017. Connect an electromagnetic relay circuit that turns on a lamp.

Electrical Energy Source Analysis

AES-018. Construct an electrical energy source that responds to chemicals, light, heat, and pressure.

AES-019. Construct an electromagnetic generator.

AES-020. Evaluate the operation of an AC circuit with respect to values, phase, frequency, and alternations.

AC System and Component Analysis

AES-021. Measure AC voltage with a VOM and determination of rms, peak, peak-to-peak, and instantaneous values.

AES-022. Examine the components of an AC system.

*AES-023. Evaluate L-R and R-C circuits.

*AES-024. Observe AC on an oscilloscope.

*AES-025. Examine a transformer.

*AES-026. Measure the response of an R-C and L-R time constant.

Diode Devices

*AES-027. Examine and test semiconductor materials.

*AES-028. Determine the characteristics of a diode and test one with an ohmmeter.

*AES-029. Determine the characteristics of a zener diode, LED, and a photodiode.

*AES-030. Examine a half-wave power supply.

*AES-031. Examine a full-wave power supply.

*AES-032. Examine power supply filtering and regulation.

Amplifying Devices

*AES-033. Identify the leads and test a bipolar transistor, JFET, MOSFET, and UJT.

*AES-034. Examine the characteristic curves of a bipolar transistor, JFET, MOSFET, and UJT.

*AES-035. Determine the operating regions of a bipolar transistor.

*AES-036. Construct a bipolar transistor amplifier and examine the different bias methods, classes of operation and circuit configurations.

*AES-037. Construct a JFET common-source amplifier.

*AES-038. Examine the inverting and noninverting characteristics of an operational amplifier.

*AES-039. Examine a small signal and a power amplifier circuit.

Electronic Oscillators

*AES-040. Construct a relaxation oscillator with a UJT.

AES-041. Examine the operation of some nonsine wave oscillators.

AES-042. Construct a sine wave oscillator.

*AES-043. Construct an astable multivibrator oscillator with an NE555 timer.

Communication Electronic System Analysis

AES-044. Communicate with a person by sound, graphic symbols, and light. Discuss the limitations of each method.

*AES-045. Examine a CW communication system and send coded messages.

AES-046. Determine what it takes to communicate sound or voice over wires.

*AES-047. Investigate the principles of a radio communication system.

AES-048. Construct an AM transmitter and send messages.

AES-049. Construct an FM wireless microphone and send messages.

*AES-050. Investigate the principles of television and examine circuitry of a TV receiver.

Digital Electronic Systems

AES-051. Discuss the differences between analog and digital systems.

*AES-052. Investigate different numbering systems.

*AES-053. Examine AND, OR, NOT, NAND, and NOR logic gates and determine the unique differences.

*AES-054. Examine the operation of clocks, RS, RST, and JK flip-flops.

*AES-055. Evaluate the operation of counters, registers, decoders, and drivers.

AES-056. Evaluate the operation of single number and seven-segment displays.

*AES-057. Investigate the fundamental components of different digital systems.

Electronic Power Control Systems

AES-058. Analyze an electronic power control system and its fundamental parts.

*AES-059. Test an SCR, identify its leads, and analyze its characteristics.

*AES-060. Construct SCR power control circuits with AC and DC.

*AES-061. Test a triac, identify its leads, and analyze its characteristics.

*AES-062. Build a triac AC power control circuit.

Electronic System Transducers

AES-063. Define the term transducer and discuss the differences between active and passive devices.

AES-064. Examine the functional characteristics of active transducers that respond to light, heat, sound, and electromagnetic energy.

AES-065. Examine the functional characteristics of passive transducers that respond to light, heat, and sound.

Industrial Process Control Systems

*AES-066. Analyze industrial processes that respond to heat, light, liquid level, flow, number, rotational speed, electrical conductivity, or chemical changes.

*AES-067. Develop a control system that responds to any of the previous industrial processes.

*AES-068. Develop a control system for a different industrial process and demonstrate its ability to achieve control.

AES-069. Investigate the operation of a programmable controller and connect it; achieve three different forms of control.

Robotic Systems

*AES-070. Analyze the operation of a robotic system and classify different systems.

*AES-071. Investigate the manipulator, controller, and power source of a robotic system.

*AES-072. Examine the mechanical parts, sensors, degrees of freedom and control procedures of a robotic system.

AES-073. Examine different programming procedures.

STUDENT COMPETENCY RECORD

School________________________
Student________________________
School Year________________________
Instructor's Name________________________
Course Title Advanced Electronic Systems
Classification________________________

Student Address________________________
________________________ ________ Zip
Comments________________________

The student should be evaluated according to the performance ratings listed. Indicate on this form the numeric rating of the student's performance for each item.

(1) Competency in Process
(2) Competency Performed with Close Supervision
(3) Competency Performed with Limited Supervision
(4) Competency Performed without Supervision

* Use for eighteen weeks course.

COMPETENCIES

	*AES-001.	Define Electrical System Parts.
	*AES-002.	Describe the operation of a flashlight.
	*AES-003.	Examine the structure of matter, static electricity, and the laws of attraction and repulsion.
	*AES-004.	Solder electrical conductors and measure their size.
	*AES-005.	Discuss the rules of electrical safety.
	*AES-006.	Draw the components of an electrical system with symbols to form a schematic diagram.
	*AES-007.	Determine the value of resistors by color code and measure resistance with an ohmmeter.
	*AES-008.	Measure DC voltage and current with a single function meter and a multifunction meter or VOM.
	*AES-009.	Build a simple DC electric circuit and define the relationship between V, I, R, and W.
	*AES-010.	Construct a series DC circuit and evaluate the V, I, R, and W.

	*AES-011.	Construct a parallel DC circuit and evaluate the V, I, R, and W.
	*AES-012.	Construct a combination circuit and evaluate the V, I, R, and W.
	*AES-013.	Determine component values of a circuit by calculation.
	AES-014.	Develop a field diagram of a bar magnet.
	AES-015.	Magnetize and demagnetize an iron bar.
	AES-016.	Build an electromagnet and evaluate the operation of an electromagnet.
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	AES-019.	Construct an electromagnetic generator.
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	AES-022.	Examine the components of an AC system.

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	*AES-024.	Observe AC on an oscilloscope.
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	*AES-066.	Analyze industrial processes that respond to heat, light, liquid level, flow, number, rotational speed, electrical conductivity, or chemical changes.
	*AES-067.	Develop a control system that responds to any of the previous industrial processes.

	*AES-068.	Develop a control system for a different industrial process and demonstrate its ability to achieve control.
	*AES-069.	Investigate the operation of a programmable controller and connect it; achieve three different forms of control.
	*AES-070.	Analyze the operation of a robotic system and classify different systems.
	*AES-071.	Investigate the manipulator, controller, and power source of a robotic system.
	*AES-072.	Examine the mechanical parts, sensors, degrees of freedom and control procedures of a robotic system.
	AES-073.	Examine different programming procedures.

MANAGEMENT SHEETS

* ANALYZING ELECTRICAL AND ELECTRONIC SYSTEMS

INTRODUCTION: All electrical systems are made up of an energy source, path, control, load, and indicator. The energy source supplies energy to operate the system. Energy follows the path from the source to the load. Control alters the operation of the system. This can be simply an on/off operation. The load does work. The indicator shows that the system is operational.

PERFORMANCE OBJECTIVE (1-2 Days)

TASK/COMPETENCY: AES-001. Define Electrical System Parts.

EQUIPMENT AND SUPPLIES: Flashlight, meters, AM radio receiver, and other electrical systems.

STANDARD OF PERFORMANCE: Electrical system parts should be defined with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Dugger and Garrish. b. Understanding Electronic Systems Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 001

TEACHER	STUDENT
*1. Have students read "Basics of Electricity" of recommended text.	*1. Read "Basics of Electricity" in recommended text.
*2. Draw block diagrams on chalkboard that identify the basic electrical parts of a system.	*2. Be able to identify basic electrical system parts.
*3. Explain the function of the source, path, control, load, and indicator.	*3. Prepare a brief explanation of the function of electrical system parts.
*4. Discuss the make up of other electrical systems. Examples: a. Headlights of an automobile. b. Lights in a home. c. AM radio receiver. d. Electrical power system.	*4. Draw block diagrams of electrical systems noting the actual components being used.

EVALUATION CRITERIA: The source, path, control, load and indicator of an electrical system should be identified and defined with 70% accuracy.

* ANALYZING ELECTRICAL AND ELECTRONIC SYSTEMS

INTRODUCTION: A flashlight is a simple electrical system that has all of the the fundamental parts readily available. Dry cells serve as the energy source. Metal strips or the case provide a path for energy to follow. A slide switch achieves control. The lamp serves as the load. It changes chemical energy into light. This also serves as an indicator.

PERFORMANCE OBJECTIVE (1-2 Days)

TASK/COMPETENCY: AES-002. Describe the operation of a flashlight.

EQUIPMENT AND SUPPLIES: Several different types of flashlights.

STANDARD OF PERFORMANCE: The electrical system of a flashlight should be described according to the evaluation criteria.

ENABLING OBJECTIVE: An understanding of the basic functions of an electrical system.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Understanding Electronic Systems Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Electroscope

ACTIVITIES 002

TEACHER	STUDENT
*1. Demonstrate the disassembly of a representative flashlight. *2. Show the fundamental parts. *3. Draw a block diagram showing the source, path, cotrol, load, and indicator. *4. Indicate the components of a flashlight that will accomplish the functions of a system. *5. Identify the components of a flashlight. *6. Make a pictorial drawing of the circuitry of a flashlight.	*1. Observe the flashlight disassembly procedure. *2. Refer to the cutaway drawing of a flashlight in Chapter 1, "Basics of Electricity" of Electricity and Electronics. *3. Disassemble a representative flashlight. a. Note the energy source, how it is connected, and the procedure for removing the energy source from the system. b. Locate the switch. Explain how the switch works. c. Locate the lamp. Note how the source is connected to the lamp. Identify the filament. d. Locate the energy path of the flashlight. What material is used for the path? *4. Make a drawing showing how the electrical components of a flashlight are connected.

EVALUATION CRITERIA: The source, path, control and load of a flashlight should be identified and diagrammed with at least 70% accuracy.

INTRODUCTION: The structure of matter is very important in the study of electricity. Matter is made of elements. An element can be divided into electrons, protons and neutrons. Electricity responds to the movement of electrons in a material. This is called current electricity. Static electricity is produced by friction.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-003. Examine the structure of matter, static electricity, and the laws of attraction and repulsion.

EQUIPMENT AND SUPPLIES: Small pieces of plastic, wool, fur, silk, a comb, and paper pieces.

STANDARD OF PERFORMANCE: Generate static electricity.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Electroscope. Sargent-Welch Scientific Company.

1 - Electrostatic Generator, Van de graaff type. Sargent-Welch Scientific Company.

ACTIVITIES 003

TEACHER	STUDENT
*1. Have students read "Basics of Electricity" of recommended text. Specifically refer to the sections on structure of matter, electrical charges, and static electricity.	*1. Read sections of recommended text dealing with structure of matter, electrical charges, and static electricity.
*2. Discuss the structure of matter. Explain the difference between solids, liquids and gases.	*2. Make drawings of the atomic structure of different elements.
*3. Discuss the structure of an atom. Demonstrate that like charges repel and unlike charges attract.	*3. Describe the differences between solids, liquids and gases.
*4. Discuss static electricity and demonstrate some common examples such as: comb, balloon/sweater and plastic/silk.	*4. Do the "Static Electricity Activity" at the end of Chapter 1, "Basics of Electricity."

INTRODUCTION: Wires and metal strips are soldered together to assure that they become good electrical conductors. A conductor serves as the path for electrical energy to follow in the operation of a system. The resistance of a conductor is based directly on its size.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-004. Solder electrical conductors and measure their size.

EQUIPMENT AND SUPPLIES: Soldering guns, soldering pencils, rosin core solder, wires, miscellaneous components, printed circuit boards and a wire gauge.

STANDARD OF PERFORMANCE: Soldering should be performed according to the evaluation criteria.

ENABLING OBJECTIVE: Ability to sense when something is hot and to work safely with heated tools and materials.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Everything You Need To Know About Soldering. Heathkit, #EI-3133.	

SELECTED AUDIOVISUAL MATERIALS:

Video Course on Soldering. Heath Company, Dept. 518-000, Benton Harbor, MI 49022.

ACTIVITIES 004

TEACHER	STUDENT
*1. Have students read Appendix 2, "Soldering" of Electricity and Electronics.	*1. Read Appendix 2, "Soldering" of Electricity and Electronics.
*2. Demonstrate the operation of a soldering pencil and soldering gun. Show how to energize the device and its hot area. Note the tip cleaning procedure and describe safe operating procedures. Demonstrate the use of a desoldering tool.	*2. Observe the operation of a soldering pencil and gun. Note the location of the "hot" area of the tool. See how the tip is cleaned and tinned.
*3. Demonstrate the use of a wire gauge.	*3. Do the "Soldering Activity" of Electricity and Electronics at the end of Chapter 1, "Basics of Electricity."
	*4. Do the "Electrical Conductors Activity" of Electricity and Electronics at the end of Chapter 1, "Basics of Electricity."

EVALUATION CRITERIA: Determine the quality of a soldered connection by seeing if the connection has been properly heated, if the solder flows to all parts, and if it has a shiny appearance.

* ANALYZING ELECTRICAL AND ELECTRONIC SYSTEMS

INTRODUCTION: The rules of electrical safety are based on an understanding of the voltage, current, and resistance of an electrical system. Essentially, a low resistance path across a voltage source will cause large amounts of current to flow.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-005. Discuss the rules of electrical safety.

EQUIPMENT AND SUPPLIES: Demonstration circuit components.

STANDARD OF PERFORMANCE: Perform 100% on an electrical safety rules test.

ENABLING OBJECTIVE: An understanding of V, I, and R in the operation of a system.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - 5A Fuse, 1 - Fuse holder, 1 - DC voltage source, 1 - 10 ohm 5 watt resistor, 120 V AC source.

ACTIVITIES 005

TEACHER	STUDENT
*1. Have students read Electric Current, Electrical Force (Voltage), Resistance and Voltage, Current, and Resistance of Chapter 1, "Basics of Electricity" of Electricity and Electronics.	*1. Read assigned sections of Chapter 1, "Basics of Electricity".
*2. Discuss the principles of current electricity related to V, I, and R. Point out that a source of voltage is needed to produce current through resistance. Show the importance of insulating material.	*2. Explain the operation of an electrical circuit with respect to voltage, current, and resistance.
*3. Demonstrate the blowing of a fuse with an electrical circuit that improperly connected.	*3. Note the safe operating procedures to be followed in the laboratory.
*4. Caution the class about using 120 V AC, and low voltage DC.	*4. Observe the effect of an overloaded circuit. Indicate the significance of heat in a circuit.
*5. Prepare a safety rules test.	*5. Note the hazards of working with "high voltage" and "low voltage" circuits.
	*6. Take a safety rules test.

* ANALYZING ELECTRICAL SYSTEM COMPONENTS

INTRODUCTION: Electrical symbols are a shorthand method of representing electrical components. Schematic diagrams are representations of electrical circuits in symbol form. It is important a person working with electrical circuits be able to identify symbols correctly.

PERFORMANCE OBJECTIVE (1 Day)

TASK/COMPETENCY: AES-006. Draw the components of an electrical system with symbols to form a schematic diagram.

EQUIPMENT AND SUPPLIES: Some representative circuit components such as: resistors, switches, lamps, batteries, and meters.

STANDARD OF PERFORMANCE: Symbol identification and reproduction should be performed with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Garrish and Dugger. b. Understanding Electronic Systems, Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

Video Tape - Basic Electricity DC #E11 Circuits, Symbols and Diagrams. Bergwall Video Products, Inc., P.O. Box 238, Garden City, NY 11530-0238.

Electrical and Electronic Symbols Chart. Graymark International Inc., 3404 West Castor, Santa Ana, CA 92704.

ACTIVITIES 006

TEACHER	STUDENT
*1. Have students read "Components, Symbols and Diagrams of Electrical Components and Measurements," Chapter 2 of Electricity and Electronics by Patrick and Fardo.	*1. Read the section of the recommended text dealing with "Components, Symbols, and Diagrams of Electrical Components and Measurements" of Electricity and Electronics by Patrick and Fardo.
*2. Draw component symbols on a chalkboard to show the relationship between system components and actual parts. Use component chart.	*2. Note the relationship between electrical symbols and the actual component parts.
*3. Refer to Appendix 4, Symbols for Electricity and Electronics of Electricity and Electronics by Patrick and Fardo.	*3. Review Appendix 4, Symbols for Electricity and Electronics of Electricity and Electronics by Patrick and Fardo.
*4. Draw component diagrams on the chalkboard to show how symbols are connected to form schematic diagrams.	*4. Make drawings of simple schematic diagrams.
*5. Demonstrate crossing conductors in a diagram.	*5. Make a drawing of circuit with crossing conductors and connected conductors.
*6. Give a quiz asking that several of the common symbols be drawn. Make a simple schematic diagram.	*6. Take a quiz.

* ANALYZING ELECTRICAL SYSTEM COMPONENTS

INTRODUCTION: Resistors offer opposition to the flow of current. Fixed resistor values are frequently identified by a color code. The colors represent numerical values and multipliers. An ohmmeter is used to measure the value of a resistor.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-007. Determine the value of resistors by color code and measure resistance with an ohmmeter.

EQUIPMENT AND SUPPLIES: An assortment of color coded resistors, a VOM or ohmmeter digital or analog.

STANDARD OF PERFORMANCE: The value of a resistor should be determined by its color code and it should be measured with an ohmmeter.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics by Patrick and Fardo.	a. Electricity and Electronics by Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics by Gerrish/Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

Resistor Color Code Chart. Graymark International Inc., 3404 W. Castor, Santa Ana, CA 92704.

ACTIVITIES 007

TEACHER	STUDENT
*1. Have students read the "Resistors" section of Electrical Components and Measurements of Electricity and Electronics.	*1. Read "Resistors" of Chapter 2, "Electrical Components and Measurements" of Electricity and Electronics by Patrick and Fardo.
*2. Demonstrate the resistor color method of identifying resistor values.	*2. Identify several resistors by the color code method.
*3. Demonstrate the operation of a laboratory VOM to measure resistance. Indicate that an ohmmeter is an indicator and a functioning system. Distinguish between analog and digital VOM's.	*3. Measure resistance of a resistor with a VOM to verify its value. Determine the value of several resistors.
*4. Demonstrate the operation of an ohmmeter in testing the value of a potentiometer.	*4. Measure the resistance of a potentiometer with an ohmmeter.
*5. Describe some of the common resistor values used to identify resistors such as K ohm and M ohm.	*5. Use K and M ohm values to indicate resistors.

EVALUATION CRITERIA: Resistor values should be determined by color code and the value verified by an ohmmeter test. This should be done with at least 70% accuracy.

* ANALYZING ELECTRICAL SYSTEM COMPONENTS

INTRODUCTION: When a meter is used to measure voltage or current, it is energized by the circuit being tested. Meters must be connected properly or they may be permanently damaged. Ammeters are connected in series with the path and voltmeters are connected across the voltage source or in parallel

PERFORMANCE OBJECTIVE (2 - 3 Days)

TASK/COMPETENCY: AES-008. Measure DC voltage and current with a single function meter and a multifunction meter or VOM.

EQUIPMENT AND SUPPLIES: VOM, assortment of dry cells, low voltage source of DC, variable DC power supply, a SPST switch and 6 V lamp.

STANDARD OF PERFORMANCE: Voltmeters and ammeters must be connected properly 100% of the time. The readings can be made with 90% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

Meter scale overhead transparency of laboratory meter - self made.

Video tape: Multimeters Explained #1 - An Introduction. Bergwall Video Productions, Inc., P.O. Box 238, Garden City, NY 11530-0238.

ACTIVITIES 008

TEACHER	STUDENT
*1. Have students read the Measuring Voltage section of Chapter 2, "Electrical Components and Measurements" of Electricity and Electronics by Patrick and Fardo.	*1. Read Measuring Voltage of Chapter 2, "Electrical Components and Measurements" of Electricity and Electronics.
*2. Demonstrate the procedure for measuring voltage with the laboratory VOM. Describe the meter scale and show some representative values obtained on the scale. Note the multiple scales of the meter and describe the scale selection procedure for a particular voltage range.	*2. Follow the voltmeter set-up demonstration. Make a list of the procedures needed to prepare a VOM to measure voltage.
*3. If digital VOM's are available demonstrate the procedure needed to read voltage values on this instrument.	*3. Follow the set-up procedure demonstration or use of a digital VOM. Make an itemized list of the procedures needed to prepare the meter to measure voltage.
*4. Have the class measure some actual DC voltage values.	*4. Use the laboratory VOM to measure some low voltage DC values. Have the instructor approve of your meter connection procedure.
*5. Have students read the Measuring Current section of Chapter 2, "Electrical Components and Measurements of Electricity and Electronics by Patrick and Fardo.	*5. Read Measuring Current of Chapter 2, "Electrical Components and Measurements" of Electricity and Electronics.
*6. Demonstrate the procedure for measuring current with the laboratory VOM. Show the scales to be used and selection of different ranges. Stress that current is measured by connecting the meter in series with the path. Note the influence that polarity has on meter deflection.	*6. Follow the ammeter set-up demonstration. Make a step by step set-up procedural list for current measurements.
	*7. Using a 6 V DC source and lamp connected in a circuit, measure the current. Do not energize your circuit until the instructor has approved of the meter connection.

*7. Have the class measure the current of a 6 V lamp circuit such as Fig. 2-28 of Electricity and Electronics.	

EVALUATION CRITERIA: Meter use should be demonstrated on a performance test with at least 70% accuracy.

* ANALYZING DC ELECTRICAL CIRCUIT OPERATION AND COMPONENT FUNCTIONS

INTRODUCTION: A simple DC circuit has an energy source, one component and one path. When the circuit is energized current flows and power is consumed. Voltage, current, resistance, and wattage can be measured to verify the operation of the circuit.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-009. Build a simple DC electric circuit and define the relationship between V, I, R, and W.

EQUIPMENT AND SUPPLIES: 6 V battery or DC power source, 6 V lamp, 100 ohm - 1 watt resistor, VOM.

STANDARD OF PERFORMANCE: Construct a DC electrical circuit, connect meters, and make measurements with 70% accuracy.

ENABLING OBJECTIVE: Electrical component identification, VOM use to measure current, voltage, and resistance.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

Ohm's Law Chart. Graymark International Inc., 3404 West Castor, Santa Ana, CA 92704.

Video tape - "#E10 Voltage and Current", Bergwall Video Productions Inc., P.O. Box 238, Garden City, NY 11530-0238.

ACTIVITIES 009

TEACHER	STUDENT
*1. Have students read the Ohm's Law section of Chapter 3, "Electrical Circuits" of Electricity and Electronics by Patrick and Fardo.	*1. Read Ohm's Law of Electricity and Electronics.
*2. Demonstrate the circuit construction procedure to be followed in the activity.	*2. Observe the procedures for connecting a simple DC circuit.
*3. Review the use of the VOM for measuring voltage, current, and resistance.	*3. Follow the review of VOM setup to mesure V, I, R.
*4. On a chalkboard calculate the current, voltage, resistance and wattage of a simple circuit.	*4. Calculate the R, V, I, and W values for a circuit using 6 V, and a #46 lamp.
*5. Supply the parts needed to build a simple circuit with a lamp.	*5. Build a simple circuit with a 6 V source and a #46 lamp.
*6. Replace the lamp with a 100 ohm resistor and measure the I and V. Calculate R and W.	*6. Measure the operational voltage, current, and resistance of the lamp. Calculate I, R, and W.
	*7. Replace the lamp with a 100 ohm resistor. Measure V, I, and R. Calculate I, R, and W. How do the circuits compare?

EVALUATION CRITERIA: Electrical circuit construction meter connections, and measurements should be determined by a performance test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-010. Construct a series DC circuit and evaluate the V, I, R, and W.

EQUIPMENT AND SUPPLIES: 6 V battery or DC power supply, resistors: 470, 330, and 220 ohms 1/2 watt, VOM.

STANDARD OF PERFORMANCE: Construct a series circuit, connect meters, and make measurements with 70% accuracy.

ENABLING OBJECTIVE: Identifying resistor color codes, measuring voltage, current, and resistance with a VOM.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

Ohm's Law Chart. Graymark International Inc., 3404 West Castor, Santa Ana, CA 92704.

ACTIVITIES 010

TEACHER	STUDENT
*1. Have students read the Series Electrical Circuits section of Electricity and Electronics by Patrick and Fardo.	*1. Read Series Electrical Circuits of Electricity and Electronics.
*2. Demonstrate the circuit construction procedure. Describe the voltage measurement procedure by showing how the meter is connected across each resistor. Show how current is measured. Explain the characteristics of a series circuit.	*2. Observe the procedures for connecting a series circuit. Follow the procedure for measuring V and I.
*3. On a chalkboard calculate the current, voltage, resistance and wattage of a series circuit.	*3. Note the characteristics of a series circuit.
*4. Supply the parts needed to build the series circuit.	*4. Do the "Series-Circuit Measurement Activity" of Electricity and Electronics by Patrick and Fardo.
*5. If time permits have the location of resistors altered and repeat the "Series-Circuit Measurement Activity."	

EVALUATION CRITERIA: Electrical circuit construction, meter connection, and measured values should be determined by a performance test with at least 70% accuracy.

* ANALYZING DC ELECTRICAL CIRCUIT OPERATION AND COMPONENT FUNCTIONS

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-011. Construct a parallel DC circuit and evaluate the V, I, R, and W.

EQUIPMENT AND SUPPLIES: 6 V battery or DC power supply, resistors 470, 330, and 220 ohms 1/2 watt, VOM.

STANDARD OF PERFORMANCE: Parallel circuit construction, meter connections, and measurements should be made with 70% accuracy.

ENABLING OBJECTIVE: Identifying resistors by color code, measuring resistance, voltage, and current with a VOM.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	

ACTIVITIES 011

TEACHER	STUDENT
*1. Have students read the Parallel Electrical Circuits section of "Electrical Circuits" of Electricity and Electronics by Patrick and Fardo.	*1. Read Parallel Electrical Circuits of Electricity and Electronics.
*2. Demonstrate the circuit construction procedure. Show how voltage is measured across each resistor and how current is measured in each parallel leg of the circuit.	*2. Observe the procedures for connecting a parallel circuit. Follow the procedure for measuring V, I, and R of the circuit and for each parallel branch.
*3. Describe the characteristics of a parallel circuit.	*3. Note the characteristics of a parallel circuit.
*4. On a chalkboard calculate the current in each parallel leg of the circuit.	*4. Do the "Parallel Circuit Measurement Activity" of Electricity and Electronics by Patrick and Fardo.
*5. Supply the parts needed to build a parallel circuit.	

EVALUATION CRITERIA: Electrical circuit construction, meter connections, and measured values should be determined by a performance test with at least 70% accuracy.

* ANALYZING DC ELECTRICAL CIRCUIT OPERATION AND COMPONENT FUNCTIONS

INTRODUCTION: A combination circuit contains series and parallel connected components in a composite diagram. This type of circuit involves both series characteristics and parallel characteristics. Combination circuits have a wide range of complexity.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-012. Construct a combination circuit and evaluate the V, I, R, and W.

EQUIPMENT AND SUPPLIES: 6 V battery or DC power supply, resistors 470, 330, and 220 ohm 1/2 watt, VOM.

STANDARD OF PERFORMANCE: Circuit construction and measurements should be made with 70% accuracy.

ENABLING OBJECTIVE: Identifying resistors connected in series and parallel in a composite circuit.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 012

TEACHER	STUDENT
*1. Have students read the Combination Electrical Circuits section of "Electrical Circuits" of Electricity and Electronics by Patrick and Fardo.	*1. Read Combination Electrical Circuits of Electricity and Electronics.
*2. Demonstrate the procedure for constructing a combination circuit. Show how voltage is measured across components and how current is measured in particular parts of the circuit. Describe the procedure for measuring the resistance of specific components, branch circuits, and total circuit resistance.	*2. Observe the procedure for constructing a combination circuit. Follow the outlined procedure for measuring V, I, and R.
*3. Describe the characteristics of a combination circuit.	*3. Note the characteristics of a combination circuit.
*4. On a chalkboard calculate the current, voltage, and wattage that appears at each resistor.	*4. Do the "Combination Circuit Measurement Activity" of Electricity and Electronics by Patrick and Fardo.
*5. Supply the parts needed to build a combination circuit.	

EVALUATION CRITERIA: Electrical circuit construction and measured values should be determined by a performance test with at least 70% accuracy.

* ANALYZING DC ELECTRICAL CIRCUIT OPERATION AND COMPONENT FUNCTIONS

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-013. Determine component values of a circuit by calculation.

STANDARD OF PERFORMANCE: Circuit calculations should be done with 70% accuracy.

ENABLING OBJECTIVE: Basic math skills.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Modern Electronics by D. Bruce.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 013

TEACHER	STUDENT
*1. Have the students review the Series Electrical Circuits, Parallel Electrical Circuits, and Combination Electrical Circuits sections of *Electricity and Electronics* by Patrick and Fardo.	*1. Review Series, Parallel, and Combination Circuits of *Electricity and Electronics.*
*2. Have the students do the Using Ohm's Law Activity at the end of Chapter 3, Electrical Circuits in the text *Electricity and Electronics.*	*2. Do the "Using Ohm's Law Activity" of *Electricity and Electronics* by Patrick and Fardo.
*3. Have the students do: (a) Working with Series Circuits (b) Working with Parallel Circuits (c) Working with Combination Circuits of *Electricity and Electronics.* This can be an outside of class assignment or can be worked in class as a group.	*3. Do the "Working With Activities" at the end of Chapter 3, Electrical Circuits of *Electricity and Electronics.*
*4. Evaluate the work.	*4. Turn in assignment for evaluation.

EVALUATION CRITERIA: Component values of a circuit should be determined by calculation on a written test with at least 70% accuracy.

INVESTIGATE THE PRINCIPLES OF PERMANENT MAGNETISM AND ELECTROMAGNETISM

INTRODUCTION: Magnetism is an essential function of many electrical devices. Magnetic fields are used in meters, motors, speakers, and relays. These devices play a very important role in the operation of an electrical system.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-014. Develop a field diagram of a bar magnet.

EQUIPMENT AND SUPPLIES: 2 PM bars, 1 - sheet of paper, a container of iron filings.

STANDARD OF PERFORMANCE: The field of a bar magnet should be defined with 70% accuracy.

ENABLING OBJECTIVE: The ability to draw or sketch the field lines of a permanent magnetic field.

REFERENCES

TEACHER	STUDENT
1. Recommended	1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Modern Electronics by D. Bruce.	

SELECTED INSTRUCTIONAL MATERIALS:

An assortment of different permanent magnets.

ACTIVITIES 014

TEACHER	STUDENT
1. Have students read the Permanent Magnets section of "Magnetism and Electromagnetism" Chapter 4 of Electricity and Electronics by Patrick and Fardo. 2. Demonstrate the principles of permanent magnetism showing, field structure, attraction, repulsion, and polarity. 3. Supply the components needed to do the Working with Permanent Magnets Activity of Chapter 4 "Magnetism and Electromagnetism" of Electricity and Electronics by Patrick and Fardo.	1. Read about permanent magnets in Chapter 4 of Electricity and Electronics. 2. Participate in the presentation by making calculations, drawing field diagrams, and polarity identification. 3. Do the "Working with Permanent Magnets Activity" of Electricity and Electronics.

EVALUATION CRITERIA: The field of a bar magnet should be shown on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-015. Magnetize and demagnetize an iron bar.

EQUIPMENT AND SUPPLIES: 1 - PM bar magnet, 1 - bar of cold rolled steel, or high carbon tool steel, 1 - compass, 1 - 200 turn coil of wire, 1 - DC source, and 1 - AC source.

STANDARD OF PERFORMANCE: A metal bar should be magnetized and demagnetized.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Modern Electronics by D. Bruce.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 015

TEACHER	STUDENT
1. Have students read the "Domain" Theory of Magnetism section of "Magnetism and Electromagnetism" Chapter 4 of Electricity and Electronics by Patrick and Fardo. 2. Demonstrate how an artificial magnet is made by rubbing a known PM on a piece of high carbon steel. Point out that only some alloys of metal can be magnetized. 3. Demonstrate how an artificial magnet can be formed by placing it in an electromagnetic field. Demagnetize a piece of steel by placing it in an AC electromagnetic field.	1. Read about the "Domain" Theory of permanent magnets in Chapter 4 of Electricity and Electronics. 2. Observe how an artificial PM is made by induction. 3. Do the "Magnetizing an Iron Bar Activity" of Electricity and Electronics. 4. Determine the polarity of the magnetized bar with a compass. 5. Demagnetize the metal bar. 6. Magnetize a metal bar with a DC electromagnetic field.

EVALUATION CRITERIA: Demonstrate how to magnetize and demagnetize a metal bar and explain the procedure on a written test with at least 70% accuracy.

INVESTIGATE THE PRINCIPLES OF PERMANENT MAGNETISM AND ELECTROMAGNETISM

INTRODUCTION: An electromagnet is a coil of wire that is energized by a source of electrical energy. When the coil is energized, it produces a magnetic field. Removing energy from the coil disables the magnetic field, and electromagnet can be turned on and off, have its polarity reversed, and strength varied.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-016. Build an electromagnet and evaluate the operation of an electromagnet.

EQUIPMENT AND SUPPLIES: 3/8" to 3/4" diameter bolt 2" long, 20' of 18 to 24 AWG enamelled wire, 6 V battery, 1 - compass.

STANDARD OF PERFORMANCE: Construct an electromagnet that produces a field when energized and loses its field when power is removed.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Modern Electronics by D. Bruce.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 016

TEACHER	STUDENT
1. Have students read the Electromagnets section of "Magnetism and Electromagnetism" Chapter 4 of Electricity and Electronics by Patrick and Fardo.	1. Read Electromagnetism in Chapter 4 of Electricity and Electronics.
2. Discuss the principles of electromagnetism. On a chalkboard diagram a coil and show its resulting field. Point out polarity and discuss the "left-hand rule of magnetism."	2. Take part in the presentation of electromagnet principles by drawing field diagrams and circuit connections.
3. Demonstrate the winding of a coil for an electromagnet. Show insulation removal and how the strength of a field can be varied and turned on and off.	3. Do the activity "Making an Electromagnet" of Electricity and Electronics.
4. Ask the class members to prepare a paper discussing the construction and operation of an electromagnet.	4. Test the polarity of your electromagnet with a compass. Reverse the polarity of the electromagnet. Pick up small pieces of metal with the electromagnet.
	5. Prepare a paper discussing the construction of an electromagnet.

EVALUATION CRITERIA: Explain how an electromagnetic field is produced and removed from a metal bar on a written test with at least 70% accuracy.

INTRODUCTION: Relays are a common application of electromagnets. A relay has an electromagnetic coil, switch contacts, and a moving element called an armature. When the coil is energized it actuates the armature which in turn controls the operation of the switch contact.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-017. Connect an electromagnetic relay circuit that turns on a lamp.

EQUIPMENT AND SUPPLIES: 1 - 6 V battery or DC power source, 1 - 6 V relay with SPDT contacts, 1.5 V dry cell, 2 - lamps.

STANDARD OF PERFORMANCE: Construct an electromagnetic relay circuit that will control the operation of a lamp.

ENABLING OBJECTIVE Identification of electrical components and an understanding of electromagnet operation.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Modern Electronics by D. Bruce.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 017

TEACHER	STUDENT
1. Have students read the Electricity Produced by Magnetism section of "Magnetism and Electromagnetism" Chapter 4 of Electricity and Electronics by Patrick and Fardo.	1. Read "Electricity Produced by Magnetism" of Electricity and Electronics.
2. Discuss the operation of a relay.	2. Note the symbol representations used with relays and make diagrams of circuit connections.
3. Draw a diagram of a relay on the chalkboard and show how it is connected to control the turn on of lamps.	3. Examine the relay and test the operation of its coil. Note the contact switching operation.
4. Have the class to connect a relay control circuit for one, then two lamps.	4. Construct a relay circuit that will turn on one lamp when energized and turn off a lamp when energized.
	5. Connect the same relay to control two lamps so that one will be on and one off when the relay is actuated and in its off state.

EVALUATION CRITERIA: Explain how an electromagnetic relay is used to control the operation of a lamp on a written test with at least 70% accuracy.

ELECTRICAL ENERGY SOURCE ANALYSIS

INTRODUCTION: A source of electrical energy is essential in the operation of an electrical system. Electrical energy can be produced chemically, with heat, with light, a magnetic field and by pressure. The electrical energy may be DC or AC depending on the process.

PERFORMANCE OBJECTIVE (1 - 4 Days)

TASK/COMPETENCY: AES-018. Construct an electrical energy source that responds to chemicals, light, heat, and pressure.

EQUIPMENT AND SUPPLIES: 1 - assortment of metal strips such as: copper, lead, tin, iron; 1 - container for electrolyte, electrolyte solutions of coke, salt water, soapy water, orange juice, 1 - photovoltaic cell, 1 - assortment of dry cells, 1 - VOM.

STANDARD OF PERFORMANCE: Produce electrical energy with chemicals and other materials.

REFERENCES

TEACHER	STUDENT
1. Recommended	1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - assortment of dry cells, 1 - Photovoltaic cell, 1 - thermocouple, 1 - Microphone, 1 - Oscilloscope, 1 - phonograph cartridge.

ACTIVITIES 018

TEACHER	STUDENT
1. Have students read the chemical sources, light sources, heat sources and pressure sources sections of Chapter 5, "Electrical Energy Sources of Electricity and Electronics by Patrick and Fardo. 2. Discuss the operation of a chemical cell. Point out that two dissimilar metals placed in an electrolyte solution will produce electricity. The electrolyte solution can be acid, alkaline, or salt. 3. Demonstrate the physical makeup of a cell and show some examples of different commercially produced cells. Show the symbol of a cell or battery. 4. Discuss the operation of a photovoltaic cell. Demonstrate how they are connected in series and parallel and point out the advantages of different cell connections. 5. Demonstrate the construction of a thermocouple. Explain its operation. Show how voltage is produced by heating the junction of two dissimilar wires. Note a great deal of heat is needed to produce a few millivolts of energy.	1. Read chemical sources, light sources, heat sources, and pressure sources of Electricity and Electronics by Patrick and Fardo. 2. Do the "Chemical Cells Activity" of the "Electrical Energy Sources" chapter of Electricity and Electronics by Patrick and Fardo. 3. Measure the output voltage of some representative dry cells. Connect the cells in series and measure the output voltage. Connect two or more cells in parallel and measure the output voltage. What is the advantage of conecting cells in series or parallel. 4. Do the "Light Sources of Electrical Energy Activity" of Electrical Energy Sources of Electricity and Electronics by Patrick and Fardo. 5. Participate in the discussion of thermocouple operation. Note the symbol of a thermocouple, and some examples of materials used in its operation. 6. Participate in the presentation. Explain how energy is produced by pressure.

6. Demonstrate how electrical energy is produced by a phonograph crystal. Note that this is called the prezoelectric effect. This is also the operational basis of a microphone. Show how the output of a microphone produces AC on an oscilloscope.

EVALUATION CRITERIA: Demonstrate how electrical energy is produced with selected materials and explain the procedure on a written test with at least 70% accuracy.

INTRODUCTION: A large portion of the electrical energy that we use today is produced by generators that respond to an electromagnetic field. The generated electricity can be AC or DC depending on how the energy is removed from the coil.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-019. Construct an electromagnetic generator.

EQUIPMENT AND SUPPLIES: 1 - Coil of wire made of 20' of #18 to 24 AWG wire, 1 - VOM, 1 - Permanent magnet bar.

STANDARD OF PERFORMANCE: Construct an electromagnetic generator that produces voltage.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - DC generator, 1 - Alternator, 1 - Hand-powered generator.

ACTIVITIES 019

TEACHER	STUDENT
1. Have students read the Electromagnetic Induction and Generating A Voltage sections of Chapter 5: "Electrical Energy Sources" of Electricity and Electronics by Patrick and Fardo.	1. Read Electromagnetic Induction and Generating A Voltage of Electricity and Electronics by Patrick and Fardo.
2. Show the class how to wind the coil from 20' of wire. The finished coil should be able to accomodate the PM bar.	2. Wind an air core coil that will accomodate the PM bar.
3. Demonstrate how electrical energy is produced from a magnetic field. Point out that strength of the PM field, number of turns, and field movement speed determine the induced energy.	3. Connect the wound coil to a VOM in the IMA range. Move the magnet into the coil. Note the deflection of the meter. Alter the movement speed of the magnet.
4. Demonstrate the operation of a hand-powered generator. Show the functional parts of a DC and an AC generator.	4. What factors influence the output of an electromagnetic generator?

EVALUATION CRITERIA: Explain how electromagnetic generation is achieved on a written report with 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-020. Evaluate the operation of an AC circuit with respect to values, phase, frequency, and alternations.

STANDARD OF PERFORMANCE: Calculations made with 70% accuracy.

ENABLING OBJECTIVE Basic mathematic operations dealing with trignometeric functions of a sine wave.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, 1 - AC signal generator.

ACTIVITIES 020

TEACHER	STUDENT
1. Have students read the Generating A Voltage, Electrical Generator Basics, Single-Phase Generators, and Three-Phase Generators sections of Chapter 5: "Electrical Energy Sources" of Electricity and Electronics by Patrick and Fardo.	1. Read Generating A Voltage, Electrical Generator Basics, Single-Phase Generators, and Three-Phase Generators of Electricity and Electronics by Patrick and Fardo.
2. Discuss the formation of a sine wave by an AC generator. Point out instantaneous values, peak values, peak-to-peak values, average values, and rms values. Show the + and - alternations of sine wave and indicate different degrees of rotation from 0 to 360 degrees.	2. Note the different parts of a waveform and be able to define different values.
3. Calculate different AC values.	3. Work AC generator problems.
4. Show a sine wave on an oscilloscope. Point out the alternations, peak-to-peak values, influence of frequency and phase of the wave.	4. Observe oscilloscope waves. Make drawings of AC waves pointing out values, phase and frequency.

EVALUATION CRITERIA: Calculate different AC values from certain givens, on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-021. Measure AC voltage with a VOM and determination of rms, peak, peak-to-peak, and instantaneous values.

EQUIPMENT AND SUPPLIES: 1 - 12.6 VCT transformer, 1 - VOM, 1 - #46 lamp.

STANDARD OF PERFORMANCE: Circuit construction, measurements, and calculations should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Modern Electronics: Basics, Devices, and Applications by D. Bruce.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

Overhead projector, meter scale, transparency.

ACTIVITIES 021

TEACHER	STUDENT
*1. Have students read the Alternating Current Voltage, Single-Phase and Three-Phase AC, and Measuring AC Voltage with A VOM sections of Chapter 6: "Alternating Current Electricity" of Electricity and Electronics by Patrick and Fardo.	*1. Read the Alternating Current Voltage, Single-Phase and Three-Phase AC, and Measuring AC Voltage with A VOM sections of Electricity and Electronics by Patrick and Fardo.
*2. Demonstrate the calculation of rms, average value, peak value, and peak-to-peak values on a chalkboard.	*2. Do the AC Values Activity at the end of Chapter 6: AC Electricity, of Electricity and Electronics.
*3. Review the procedure for preparing a VOM to function as a voltmeter. Show how the VOM is used to measure voltage. Point out the AC scale of the VOM.	*3. Prepare the VOM to measure low voltage from a transformer.
*4. Draw an AC circuit with low voltage from a transformer connected to a lamp. Show how the rms voltage of the circuit is measured. Calculate peak, and peak-to-peak values.	*4. Connect 6.3V AC to a #46 lamp.
	*5. Measure the applied AC and record its value. What value does the meter show? Calculate peak, and peak-to-peak values.

EVALUATION CRITERIA: Measured and calculated values should be at least 70% accurate on a written test.

* AC SYSTEM AND COMPONENT ANALYSIS

INTRODUCTION: When AC is applied to a capacitor or an inductor there is a form of opposition called reactance. XL or XC causes a voltage drop across the respective component. This loss in voltage has a significant effect on the operation of a circuit.

PERFORMANCE OBJECTIVE (2 - 5 Days)

TASK/COMPETENCY: AES-022. Examine the components of an AC system.

EQUIPMENT AND SUPPLIES: 1 - VOM, 2 - 500 uF-50V capacitor, 6.3V AC source, #46 lamp, 1 - 25mH inductor, 2.2K-1/4 watt resistor, SPST switch.

STANDARD OF PERFORMANCE: AC component examination should be made with at least 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Modern Electronics: Basics, Devices, and Applications by D. Bruce. b. Electricity and Electronics Gerrish and Dugger.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 022

TEACHER	STUDENT
*1. Have students read Chapter 6: "AC Electricity" of Electricity and Electronics by Patrick and Fardo.	*1. Read "AC Electricity" of Electricity and Electronics by Patrick and Fardo.
*2. Demonstrate how capacitors are tested with a VOM. Describe what occurs during the "kick test" response of an ohmmeter. Show the response of both large and small capacitor values.	*2. Note the response of a VOM when testing a capacitor. Observe the "kick test" of a capacitor on a VOM.
*3. Demonstrate how inductors are tested with a VOM. Show how a shorted, open, and good inductor responds. Draw the schematic symbols and show the difference between air and metal core inductors.	*3. Record data from the inductor demonstration.
4. Explain how components are connected in series and parallel and the influence that this has on total value.	4. Do the "Inductance and Inductive Reactance" activity of Electricity and Electronics by Patrick and Fardo.
5. Supply the components needed to complete the activities.	5. Do the "Capacitance and Capacitive Reactance" activity of Chapter 6 of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: AC components should be identified on a written examination with at least 70% accuracy.

PERFORMANCE OBJECTIVE (2 - 4 Days)

TASK/COMPETENCY: AES-023. Evaluate L-R and R-C circuits.

EQUIPMENT AND SUPPLIES: 1 Henry Inductor, #46 lamp, 1 - 500uF-50V capacitor, 1 - 6.3V AC source, 6V DC source, 1 - 0.22uF-50V capacitor, 1 - VOM.

STANDARD OF PERFORMANCE: L-R and R-C circuits should be identified and evaluated with 70% accuracy.

ENABLING OBJECTIVE: Component identification and circuit connection from a schematic diagram.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 023

TEACHER	STUDENT
*1. Have students read Chapter 6, "AC Electricity" of Electricity and Electronics by Patrick and Fardo.	*1. Read "AC Electricity" of Electricity and Electronics by Patrick and Fardo.
*2. Demonstrate how an inductor and a resistor are connected together in a series circuit. Show how the voltage is measured across each component. Note the voltage values, add them and compare with the value of the applied source. Supply DC and AC to the circuit.	*2. Record data from the L-R circuit demonstration.
*3. Demonstrate how a capacitor and a resistor are connected together in a series circuit. Show how the voltage is measured across each component. Note the measured voltage values, add them, and compare with the value of the source. This should show the effect of a reactive value due to an out-of-phase condition.	*3. Record data from the R-C series demonstration.

EVALUATION CRITERIA: Data should be recorded and explained with at least 70% accuracy.

* AC SYSTEM AND COMPONENT ANALYSIS

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-024. Observe AC on an oscilloscope.

EQUIPMENT AND SUPPLIES: 1 - oscilloscope, 1 - 12.6V AC source, 1 - signal generator, 1 - 6V DC battery.

STANDARD OF PERFORMANCE: Oscilloscope operation for observing AC demonstrated with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	

ACTIVITIES 024

TEACHER	STUDENT
*1. Have students read the "Using an Oscilloscope" section of Chapter 6: AC Electricity of Electricity and Electronics by Patrick and Fardo.	*1. Read "Using an Oscilloscope" of Electricity and Electronics by Patrick and Fardo.
*2. Demonstrate the operation of a laboratory oscilloscope. Show the primary function of essential controls. Explain what each control achieves. If several scopes are available, talk the class through the operation of the scopes while letting the students adjust the controls.	*2. Do the "Oscilloscope Use" activity of Chapter 6: AC Electricity of Electricity and Electronics by Patrick and Fardo.
*3. Demonstrate the rise of a signal generator.	*3. Using the laboratory oscilloscope prepare a paper telling the name of each control and its function in the operation of an oscilloscope.
	*4. Connect a signal generator to an oscilloscope and observe the output waveform.

EVALUATION CRITERIA: The basic princples of Oscilloscope operation should be demonstrated on a performance test with at least 70% accuracy.

* AC SYSTEM AND COMPONENT ANALYSIS

INTRODUCTION: Transformers are used to step up or step down voltage and current. They are also used to match impedance. A transformer is an important system component.

PERFORMANCE OBJECTIVE (2 - 4 Days)

TASK/COMPETENCY: AES-025. Examine a transformer.

EQUIPMENT AND SUPPLIES: #24 AWG wire, #18 AWG wire, 3/4" dia. X 6" soft steel bar, 1 - VOM, 6V battery, low voltage AC source 12.6V AC.

STANDARD OF PERFORMANCE: The component parts of a transformer should be examined and identified with 70% accuracy.

ENABLING OBJECTIVE: An understanding of inductance and the resulting magnetic field produced by a conductor and a coil.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Transformer assembly unit consisting of 2 - 2" diameter coils wound of #24 wire with an open center, 2 - 2" diameter coils wound of #18 wire with an open center or 1 - Flexiformer Superior Electric Co.

ACTIVITIES 025

TEACHER	STUDENT
*1. Have students read the "Transformers" section of Chapter 6: AC Electricity of Electricity and Electronics by Patrick and Fardo.	*1. Read Transformers of Electricity and Electronics by Patrick and Fardo.
*2. Show the construction of a transformer. Point out the primary and secondary windings.	*2. Make symbol drawings of a transformer and record data from the demonstration.
3. Apply 1.5V DC to the primary and show how the field is transferred to the secondary. Place a core in the center of the coils and show how the induced field increases. Draw the schematic symbol of a transformer showing the primary and secondary.	3. Do the "Transformer Operation" activity of Chapter 6: AC Electricity of Electricity and Electronics.
4. Calculate the voltage ratio, current ratio, and efficiency of a transformer on a chalkboard.	*4. Do "Transformer Problems" of Chapter 6: AC Electricity of Electricity and Electronics.
*5. Supply the parts needed to do the transformer activities. The class may wind the coils for the activity.	

INTRODUCTION: Time constant circuits deal with the ability of a circuit to store and release energy in a given unit of time. Capacitors and inductors have the ability to store energy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-026. Measure the response of an R-C and L-R time constant.

EQUIPMENT AND SUPPLIES: 1 - VOM, 1 - 500uF-50V capacitor, 1 - 0.22uF-50V capacitor, 1 - 0.01uF-50V capacitor, 1 - SPDT switch, 6V DC source.

STANDARD OF PERFORMANCE: Measured values and the response time of R-C and L-R circuits should be made with 70% accuracy.

ENABLING OBJECTIVE: Be able to follow a schematic diagram and translate it into an actual circuit.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Modern Electronics: Basics, Devices and Applications by D. Bruce.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 026

TEACHER	STUDENT
*1. Have students read the "Time Constant Circuits" section of Chapter 6: AC Electricity of Electricity and Electronics by Patrick and Fardo.	*1. Read Time Constant Circuits of Electricity and Electronics by Patrick and Fardo.
2. Show the construction of an R-C and an L-R time constant circuit. Draw circuits on the chalkboard, show the charging function and discharging action.	2. Take data, draw symbols of R-C and L-R time constant circuits.
3. Demonstrate the electrical response of an R-C time constant circuit.	3. Record data from the R-C time constant demonstration.
4. Calculate the time constant of an R-C and an L-R circuit.	*4. Work some representative R-C and L-R time constant problems.
*5. Work some sample problems from the "AC Circuit Problems" of Chapter 6: AC Electricity of Electricity and Electronics by Patrick and Fardo.	

EVALUATION CRITERIA: Measurements should be made and explained on a written report with at least 70% accuracy.

* DIODE DEVICES

INTRODUCTION: Solid state diode devices are made up of semiconductor materials that are defined as N and P materials. The material will conduct equally well in either direction. When P and N materials are joined they form a diode. A diode has unidirectional conductivity.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-027. Examine and test semiconductor materials.

EQUIPMENT AND SUPPLIES: 1 - 2N4222 JFET, 1 - VOM, 1 - DC source.

STANDARD OF PERFORMANCE: Semiconductor material formation diagrams and activities should be completed with 70% accuracy.

ENABLING OBJECTIVE: An understanding of atomic theory.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 027

TEACHER	STUDENT
*1. Have students read Chapter 9, "Electronic Basics" of Electricity and Electronics by Patrick and Fardo.	*1. Read Chapter 9, "Electronic Basics" of Electricity and Electronics by Patrick and Fardo.
*2. Discuss semiconductor theory showing the atomic structure of semiconductors. Use Appendix 1, "The Elements" to define atomic differences. Note the classification of type IV B elements. Show how type III and V elements can be mixed to form P and N materials.	*2. Look up semiconductor elements in Appendix 1, "The Elements" of Electricity and Electronics.
*3. On the chalkboard diagram covalent bonding of semiconductor elements. Discuss hole formation in P material and electron build-up in N material.	*3. Diagram covalent bonded atoms. Prepare a brief explanation of how N and P materials are formed.
*4. Demonstrate where semiconductor materials can be found in solid state devices. Explain how the material can be tested with an ohmmeter. Use the channel of a JFET, a light dependent resistor, or thermistor.	4. Do the N-material conduction activity in Chapter 9, "Electronic Basics" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Semiconductor material activities, diagrams and explanations should be made with at least 70% accuracy.

* DIODE DEVICES

INTRODUCTION: A diode is constructed from P and N materials that are joined at a common point. Forward biasing of a diode will cause it to be conductive and reverse biasing causes it to be nonconductive. An ohmmeter can be used to test the condition of a diode.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-028. Determine the characteristics of a diode and test it with an ohmmeter.

EQUIPMENT AND SUPPLIES: 1 - Variable DC source or a 9V battery, and 25k potentiometer, 1 - VOM, 1 - IN4004 diode, 1 - 100 ohm 1/4 watt resistor.

STANDARD OF PERFORMANCE: Diode characteristic evaluation and test procedures should be achieved with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	

SELECTED INSTRUCTIONAL MATERIALS:

Data sheet for a silicon diode. Texas Instruments, P.O. Box 5012, Dallas, TX 75222.

ACTIVITIES 028

TEACHER	STUDENT
*1. Have students read the Junction Biasing, Diode Characteristics, Diode Specifications, and Diode Testing sections of Chapter 10: Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of Chapter 10: "Electronic Diode" of Electricity and Electronics by Patrick and Fardo.
*2. Discuss the characteristics of a silicon diode. Draw a representative curve on the chalkboard and point out the forward and reverse parts of the curve. Note the unique parts of the curve. Define IF, VF, IR, VR, and PIV.	2. Refer to data sheet of a silicon diode in Electricity and Electronics. Note the meaning of data values.
*3. Discuss the characteristic curve test circuit for a silicon diode. Describe the operation of the circuit and how it is altered to produce changes in voltage and current.	3. Do the "Diode Characteristics" activity of Electricity and Electronics by Patrick and Fardo.
*4. Demonstrate how a diode is tested with a VOM.	*4. Do the "Diode Testing" activity of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: An understanding of diode characteristics and test procedures should be demonstrated by completion of a written test with at least 70% accuracy.

SELECTED INSTRUCTIONAL MATERIALS:

Data sheet for a silicon diode. Texas Instruments, P.O. Box 5012, Dallas, TX 75222.

ACTIVITIES 028

TEACHER	STUDENT
*1. Have students read the Junction Biasing, Diode Characteristics, Diode Specifications, and Diode Testing sections of Chapter 10: Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of Chapter 10: "Electronic Diode" of Electricity and Electronics by Patrick and Fardo.
*2. Discuss the characteristics of a silicon diode. Draw a representative curve on the chalkboard and point out the forward and reverse parts of the curve. Note the unique parts of the curve. Define IF, VF, IR, VR, and PIV.	2. Refer to data sheet of a silicon diode in Electricity and Electronics. Note the meaning of data values.
*3. Discuss the characteristic curve test circuit for a silicon diode. Describe the operation of the circuit and is altered to produce changes in voltage and current.	3. Do the "Diode Characteristics" activity of Electricity and Electronics by Patrick and Fardo.
*4. Demonstrate how a diode is tested with a VOM.	*4. Do the "Diode Testing" activity of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: An understanding of diode characteristics and test procedures should be demonstrated by completion of a written test with at least 70% accuracy.

* DIODE DEVICES

PERFORMANCE OBJECTIVE (1 - 4 Days)

TASK/COMPETENCY: AES-029. Determine the characteristics of a zener diode, LED, and a photodiode.

EQUIPMENT AND SUPPLIES: 1 - Variable DC power source 0-25B, 1 - 25k ohm potentiometer, 1 - 5Vz 500mW zener diode, 1 - 2V LED, 1 - photodiode Motorola MRD 500, Motorola IN5231, 1 - 1M ohm 1/4W resistor.

STANDARD OF PERFORMANCE: Evaluation of diode characteristics and test procedures should be achieved with 70% accuracy.

ENABLING OBJECTIVE: Component identification and schematic diagrams translated into actual circuits.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Semiconductor Devices by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

Data sheets for the diodes used in this activity.

ACTIVITIES 029

TEACHER	STUDENT
*1. Have students read the Semiconductor Diode Devices section Chapter 10: Electronic Diode, of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of Chapter 10: "Electronic Diode" of Electricity and Electronics by Patrick and Fardo.
*2. Discuss the characteristics of a zener diode, light emitting diode, and photodiode.	*2. Do the "Zener Diode Characteristics" activity of Electricity and Electronics.
3. Show a characteristic test circuit for a zener diode, LED, and photodiode. Explain any peculiarities about the circuit with respect to meter connections, lead identification, and circuit modifications.	3. Do the "Light Emitting Diode Characteristics" activity of Electricity and Electronics.
4. Supply the parts needed to complete the assigned activities.	4. Do the "Photodiode Characteristics" activity of Electricity and Electronics.

EVALUATION CRITERIA: An understanding of diode characteristics and test procedures should be demonstrated by completion of activity sheets with at least 70% accuracy.

* DIODE DEVICES

INTRODUCTION: Power supplies provide the voltage needed to make a system function. Diodes are used to rectify the AC source voltage. Half-wave rectification changes one alternation of the AC input into a usable DC output.

PERFORMANCE OBJECTIVE (1 - 4 Days)

TASK/COMPETENCY: AES-030. Examine a half-wave power supply.

EQUIPMENT AND SUPPLIES: 1 - Transformer 12.6V CT, 1 - IN4004 diode, 1 - 500uF-50V capacitors, 1 - 1k ohm 1 watt resistor, 1 - VOM.

STANDARD OF PERFORMANCE: Half-wave power supply circuit diagrams, component testing and waveform observations should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 030

TEACHER	STUDENT
*1. Have students read the Power Supply Functions section of Chapter 11: Electronic Power Supplies of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned section of the recommended text.
*2. Discuss the makeup of a power supply in block diagram form. Then show a schematic representation of the blocks. Describe the role played by each component.	*2. Diagram the functional parts of a half-wave rectifier.
*3. Demonstrate the operation of a half-wave rectifier circuit without filtering. Show waveforms on an oscilloscope. Measure the input and DC output voltages.	*3. Do the "Half-Wave Rectifiers" activity of Electricity and Electronics by Patrick and Fardo.
*4. Discuss filtering. Draw an example of filtering on the chalkboard. Connect an oscilloscope to show filtering action. Note the effect of capacitor value and filtering action.	*4. Do the "C-Input Filtering" activity of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Half-wave circuits and test procedures should be demonstrated by completion of activities with at least 70% accuracy.

* DIODE DEVICES

INTRODUCTION: Full-wave rectification uses both alternations of the AC input to produce DC. Full-wave rectification is more efficient than half-wave rectification. Full-wave rectification can be achieved with two diodes or with four diodes in a bridge configuration.

PERFORMANCE OBJECTIVE (2 - 5 Days)

TASK/COMPETENCY: AES-031. Examine a full-wave power supply.

EQUIPMENT AND SUPPLIES: 1 - Transformer 12.6VCT, 4 - IN4004 diodes, 2 - 1k ohm 1 watt resitors.

STANDARD OF PERFORMANCE: Full-wave power supply circuit diagrams, circuit construction, and waveforms should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 031

TEACHER	STUDENT
*1. Have students read the Full-Wave Rectification, Full-Wave Bridge Rectifiers and Dual Power Supplies sections of Chapter 11: "Electronic Power Supplies" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
2. Discuss the operation of a two-diode full-wave rectifier. Point out the out-of-phase relationship of the transformer. Note the circuit connection differences between half and full-wave circuits.	2. Do the "Full-Wave Rectifiers" activity of Electricity and Electronics by Patrick and Fardo.
3. Demonstrate the operation of a two diode full-wave circuit without filtering. Calculate the DC output voltage. Show input and output waveforms on an oscilloscope.	3. Do the "Bridge Rectifiers" activity of Electricity and Electronics by Patrick and Fardo.
4. Demonstrate the operation of a bridge full-wave circuit without filtering. Point out the unique differences in input and output voltages. Calculate the DC output voltage.	*4. Do the "Dual Power Supply" activity of Electricity and Electronics by Patrick and Fardo.
*5. Show the operation of a dual power supply. Discuss the differences in circuit construction output voltages. Calculate the DC output voltage.	

EVALUATION CRITERIA: Full-wave circuits and test procedures should be demonstrated by satisfactory completion of the activities with at least 70% accuracy.

* DIODE DEVICES

INTRODUCTION: Filtering is designed to smooth out any variations in the voltage of a rectified power supply. Regulation is designed to maintain the voltage at a constant value with changes in load and input voltage.

PERFORMANCE OBJECTIVE (2 - 5 Days)

TASK/COMPETENCY: AES-032. Examine power supply filtering and regulation.

EQUIPMENT AND SUPPLIES: 1 - Transformer 12.6VCT, 4 - IN4004 diodes, 2 - 500uF-50V capacitors, 1 watt resistors: 10k, 1k, 470, and 220 ohm, 1 - 4H, 50mA inductor, 1 - IN5346A zener diode, 1 - VOM.

STANDARD OF PERFORMANCE: Filtering diagrams, circuit construction, and waveforms should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Semiconductor Devices by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 032

TEACHER	STUDENT
*1. Have students read the Filtering and Voltage regulation sections of Chapter 11: "Electronic Power Supplies" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss filtering of rectified power supply. On a chalkboard show some representative waveforms to expect. Note how the voltage level of the output changes with filtering.	*2. Do the "C-Input Filtering" activity of Electricity and Electronics by Patrick and Fardo.
*3. Demonstrate power supply filtering with an oscilloscope. Show how the ripple value is determined.	*3. Do the "L-Input Filter" activity of Electricity and Electronics by Patrick and Fardo.
*4. Discuss voltage regulation. On a chalkboard show some representative input and output values in a representative circuit. Point out where different voltage values are measured. Change the input voltage and show how the circuit changes to achieve regulation. Change the load from an infinite value to a low resistant value and note how the circuit values change.	*4. Do the L C Filters activity of Electricity and Electronics by Patrick and Fardo.
	*5. Do the "Zener Diode Regulators" activity of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Filtering diagrams, circuit construction, and waveforms should be accomplished by satisfactory completion of the activities with at least 70% accuracy.

* AMPLIFYING DEVICES

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-033. Identify the leads and test a bipolar transistor, JFET, MOSFET, and UJT.

EQUIPMENT AND SUPPLIES: 1 - VOM, 1 - Bipolar transistor 2N3397, 1 - junction field effect transistor 2N4222, 1 - MOSFET 2N3796, 1 - UJT 2N2647, 1 - 100k ohm 1/4 watt resistor.

STANDARD OF PERFORMANCE: The basic elements of transistors should be identified with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Semiconductor Devices by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 033

TEACHER	STUDENT
*1. Have students read the Bipolar Transistors, Transistor Biasing, Transistor Characteristics, and Transistor Packaging sections of Chapter 12: "Transistors" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss transistors crystal structure, element names, and biasing. Draw transistors on the chalkboard and show the crystal structure. Show how to bias a bipolar transistor.	*2. Do the "Bipolar Transistor Type Identification" activity of Electricity and Electronics by Patrick and Fardo.
*3. Demonstrate the procedure for identifying the leads of a bipolar transistor with an ohmmeter.	*3. Do the "Bipolar Transistor Lead Identification" activity of Electricity and Electronics by Patrick and Fardo.
4. Explain how the gain test of a bipolar transistor is accomplished.	4. Do the "Bipolar Gain Test" activity of Electricity and Electronics by Patrick and Fardo.
*5. Have the students read the Unipolar Transistors, Junction Field-Effect Transistors, MOSFET, and Unipolar Transistor Testing sections of Chapter 12: "Transistors" of Electricity and Electronics by Patrick and Fardo.	5. Read the assigned sections of the recommended text.
6. Discuss unipolar transistors and their crystal structure, symbols, element names and biasing.	6. Do the "JFET Testing" activity of Electricity and Electronics by Patrick and Fardo.
7. Demonstrate JFET and MOSFET testing and lead identification with an ohmmeter.	7. Do the "JFET Testing" activity of Electricity and Electronics by Patrick and Fardo.
8. Discuss unijunction transistor (UJT) crystal structure, symbols, element names, and biasing. Demonstrate the test procedure and lead identification of a UJT.	8. Identify the leads of a UJT with an ohmmeter.

EVALUATION CRITERIA: The basic elements of transistors should be identified by drawings and written explanations with 70% accuracy.

* AMPLIFYING DEVICES

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-034. Examine the characteristic curves of a bipolar transistor, JFET, MOSFET, and UJT.

STANDARD OF PERFORMANCE: Characteristic curve analysis and use should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Semiconductor Devices by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Self-made characteristic curve overhead transparency of a given transistor. The components for a bipolar transistor characteristic curve circuit, see Fig. 12-11 of recommended text. The components for a JFET drain curve test circuit, see Fig. 12-22 of the recommended text.

ACTIVITIES 034

TEACHER	STUDENT
*1. Have students read the Bipolar Characteristic Curves, JFET Characteristic Curves, and MOSFET Characteristics sections of Chapter 12: "Transistors" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Show a collector family of characteristic curves for an NPN transistor on the overhead projector. Point out different parts of the family of curves. Discuss a circuit that will permit a family of curves to be developed.	*2. Refer to the family of curves used by the instructor. Note the location of IC, VCE, and IB values. Show how a particular operating region can be used by changes in base current or voltages.
3. If time permits and if the parts are available, build a bipolar transistor curve development circuit. Demonstrate how a collector family of curves is developed. You may wish to discuss the circuit and show how values are obtained instead of building the circuit.	3. Take data for the development of a family of characteristic curves. Develop a representative family of curves.
4. If time permits and the parts are available, build a JFET drain curve test circuit. Demonstrate how a family of drain curves is developed. This procedure may be discussed instead of building the test circuit.	4. Take data for the development of a drain family of characteristic curves.

EVALUATION CRITERIA: Characteristic curve use should be demonstrated by completion of activities with at least 70% accuracy.

* AMPLIFYING DEVICES

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-035. Determine the operating regions of a bipolar transistor.

EQUIPMENT AND SUPPLIES: 1 - Bipolar transistor 2N3397, 1 - VOM, 1 - 6V battery or variable DC power supply, Resistors: 1k ohm - 1 watt, 270k ohm 1/4 watt, 56k ohm 1/4 watt.

STANDARD OF PERFORMANCE: The operating regions of a bipolar transistor should be located on a family of characteristic curves.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Understanding Semiconductor Devices by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Self-developed overhead projector transparency of a family of characteristic curves for a bipolar transistor.

ACTIVITIES 035

TEACHER	STUDENT
*1. Have students read the Operating Regions, and Characteristic Curves sections of Chapter 12: "Transistors" of Electricity and Electronics by Patrick and Fardo. *2. Discuss the operating regions of a bipolar transistor on a family of characteristic curves. Show the active, saturation, and cutoff regions. Point out how these regions of operation can be achieved by changing the bias operating point. *3. Supply the parts needed to build a circuit to show saturation and cutoff.	*1. Read the assigned sections of the recommended text. *2. Refer to family of characteristic curves used by the instructor and locate the active, saturation, and cutoff regions. Explain how an operating region is selected. *3. Do the "Transistor Operation Regions" activity at the end of Chapter 12: "Transistors" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: The operating regions of a bipolar transistor should be identified and described by written explanation with at least 70% accuracy.

PERFORMANCE OBJECTIVE (2 - 5 Days)

TASK/COMPETENCY: AES-036. Construct a bipolar transistor amplifier and examine the different bias methods, classes of operation and circuit configurations.

EQUIPMENT AND SUPPLIES: 1 - Variable DC power supply, 1 - 2N3397 transistor, Resistors: 1k ohm 1 watt, 100K ohm 1/4 watt, VOM, 2 - 10uF at 50V capacitors, 1 - AC signal generator.

STANDARD OF PERFORMANCE: Circuit construction, biasing methods, classes of operation, and circuit configurations should be made with 70% accuracy.

ENABLING OBJECTIVE

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Semiconductor Electronics by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 036

TEACHER	STUDENT
*1. Have students read the Amplification Principles, Basic Amplifiers, Classes of Amplification, and Transistor Circuit Configurations sections of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo. *2. Discuss static transistor amplifiers. Show the methods of biasing and operating point. Note the operating range, IC, IB, and VCE of the amplifier. *3. Discuss AC signal amplification. Show the function of the coupling capacitors. Point out phase changes and the location of the AC and DC signal components. *4. In a chalkboard presentation show different methods of biasing. Discuss the advantages and disadvantages of each. *5. Discuss amplifier circuit configurations. *6. Demonstrate different classes of amplification.	*1. Read the assigned sections of the recommended text. *2. Do the "Amplifier-Static Operation" activity of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo. *3. Do the "Amplifier-Dynamic Operation" activity of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo. *4. Build a class A, B, and class C amplifier by changing the bias operating point of the "Amplifier-Dynamic Operation" activity of Chapter 13: "Amplification."

EVALUATION CRITERIA: Circuit construction, biasing methods, classes of operation, and circuit configurations should be described by written explanation with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-037. Construct a JFET common-source amplifier.

EQUIPMENT AND SUPPLIES: 1 - variable DC source, 1 - JFET 2N4222, Resistors: 1.2k 1/4 watt, 10k ohm 1 watt, 1 M ohm 1/4 watt, 2 - 10uF 50V capacitors, 1 - 50uF 50 V capacitor, 1 - VOM, 1 - AC signal generator.

STANDARD OF PERFORMANCE: Circuit construction, measurements, and instrument use should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Semiconductor Electronics by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 037

TEACHER	STUDENT
*1. Have the students read "FET Biasing Methods," and "FET Circuit Configurations" sections of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the unique circuitry of a JFET AC amplifier. Point out the biasing procedure.	*2. Note the unique circuit conditions of a JFET Amplifier. Explain in writing how a reverse biased gate achieves control of ID.
*3. Show how different JFET circuit configurations can be achieved. Point out the characteristics of a common-source amplifier with respect to impedance, gain and signal phase.	*3. Do the "JFET Amplifier-Common-Source" activity of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Circuit construction procedures and instrument use should be demonstrated by activity completion with at least 70% accuracy.

PERFORMANCE OBJECTIVE (2 - 4 Days)

TASK/COMPETENCY: AES-038. Examine the inverting and noninverting characteristics of an operational amplifier.

EQUIPMENT AND SUPPLIES: 1 - LM741, 1 - split power supply, Resistors: 2 - 1k ohm 1 watt, 1 - 2.2k ohm 1/4 watt, 1 -10k ohm 1/4 watt, 1 - potentiometer 25k ohm, 1 - 10uF-50V capacitor: 1 - 1.5V dry cell, 1 - AC signal generator.

STANDARD OF PERFORMANCE: Circuit construction, gain calculations, and measurements should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Semiconductor Electronics by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 038

TEACHER	STUDENT
*1. Have students read the Integrated-Circuit Amplifiers section of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned section of the recommended text.
*2. Discuss the pin layout of an op-amp. Define the function of the inputs, output, power supply connections, and null.	*2. Draw diagrams of the pin layout of an op-amp. Note the names of different pins. Describe the function of each pin.
3. Explain the difference between open-loop and closed-loop amplifiers. Calculate voltage gain for inverting and non-inverting amplifiers.	*3. Do the "Op-Amp Circuit Noninverting" activity of Chapter 13: Amplification of Electricity and Electronics by Patrick and Fardo.
	4. Do the "Op-Amp Circuit Inverting" activity of Chapter 13: "Amplification" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Circuit construction procedure and instrument use should be demonstrated by completing the activities with at least 70% accuracy.

* AMPLIFYING DEVICES

PERFORMANCE OBJECTIVE (2 - 4 Days)

TASK/COMPETENCY: AES-039. Examine a small signal and a power amplifier circuit.

EQUIPMENT AND SUPPLIES: Optional according to circuitry selected. A single-ended AF amplifier has: 1 - 2N3053, 1 - variable DC power supply, 1 - output transformer 50 to 10 ohms, 1 - 10 ohm speaker, 1 - 50uF-50V capacitor, 1 - 5.6k ohm 1/4 watt resistor, 1 - VOM, 1 - AC signal source.

STANDARD OF PERFORMANCE: Circuit examination, instrument use, and circuit operation should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Semiconductor Electronics by Fardo and Patrick.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope

ACTIVITIES 039

TEACHER	STUDENT
*1. Have students read Chapter 14: "Amplifying Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned chapter of the recommended text.
*2. Demonstrate the operation of an AF amplifier. Have the circuit completed and operational. Apply an input signal from a signal generator and show its operation. Show some representative waves at the input and output. Calculate voltage gain. Determine power gain at the speaker.	2. Draw a schematic diagram of the AF amplifier used by the instructor. Show waveforms, representative voltage values and the signal path. Note the method of biasing used.
3. Demonstrate different input signal possibilities for an AF amplifier.	*3. Build an AF amplifier that can be energized by an AF signal source such as a microphone, phonograph or tape input. Use Fig. 14-10 "Single-ended Audio Amplifier" of Electricity and Electronics by Patrick and Fardo.
4. Show the circuitry of a push-pull AF amplifier, complementary symmetry amplifier and an IC power amplifier. Discuss the operation of each circuit.	

EVALUATION CRITERIA: Circuit examination, instrument use, and calculations should be made with 70% accuracy upon completion of the designated activities.

* ELECTRONIC OSCILLATORS

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-040. Construct a relaxation oscillator with a UJT.

EQUIPMENT AND SUPPLIES: 1 - 2N2647 UJT, 9V DC source, 470 ohm 1/4 watt resistor, 1 - 2.7k ohm 1/4 watt resistor, 1 - 10 ohm speaker, 1 - 0.1uF-50V capacitor, 1 - VOM, 1 - oscilloscope.

STANDARD OF PERFORMANCE: Circuit construction, instrument use, and diagramming should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Semiconductor Electronics by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 040

TEACHER	STUDENT
*1. Have students read the Oscillator Types, Feedback Oscillators, and Relaxation Oscillators sections of Chapter 15: "Oscillators" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
2. Demonstrate the fundamentals of oscillation. Explain how this relates to an oscillator circuit.	2. Draw a diagram of an L-C tank circuit and explain how a damped oscillatory wave is generated.
3. Show the L-C principle of wave generation. Point out the charge-discharge of C-L and the frequency.	*3. Draw a diagram of an R-C relaxation circuit. Explain how the circuit operates to produce a damped oscillatory wave.
*4. Explain the relaxation principle of an R-C circuit.	*4. Do the UJT Oscillator activity of Chapter 15: "Oscillators" of Electricity and Electronics by Patrick and Fardo.
*5. Describe the operation of a UJT relaxation oscillator.	

EVALUATION CRITERIA: Circuit construction, instrument use, and diagramming should be shown by completion of the activities with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-041. Examine the operation of some nonsine wave oscillators.

STANDARD OF PERFORMANCE: Circuit operation explanation with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Semiconductor Electronics by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope and circuit diagrams of an astable, bistable, and monostable multivibrator.

ACTIVITIES 041

TEACHER	STUDENT
1. Have students read the Astable Multivibrator, Monostable Multivibrator, and Bistable Multivibrator sections of Chapter 15: "Oscillators" of Electricity and Electronics by Patrick and Fardo.	1. Read the assigned sections of the recommended text.
2. Demonstrate the operation of an astable multivibrator. Have a circuit constructed and show the voltage and current charges that take place. Show the charge and discharge of capacitors in the base circuit. Calculate the frequency.	2. Draw a diagram of an astable multivibrator. Show the charge and discharge path of each capacitor with arrows. Explain how the circuit turns on and off.
3. Show how an astable multivibrator can be changed to a monostable circuit. Show the operational differences in the circuit. Discuss the function of triggering.	3. Diagram a monostable multivibrator Show how the circuit differs from an astable circuit.
4. Discuss the operation of a bistable multivibrator. Show the voltage changes that take place and how triggering is accomplished.	4. Diagram a bistable multivibrator. Explain how the circuit is triggered into a state change.

EVALUATION CRITERIA: Circuit operation should be explained on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-042. Construct a sine wave oscillator.

EQUIPMENT AND SUPPLIES: 1 - variable DC power supply or 9V DC, 1 - 2N3397, 3 - 0.22uF at 50V, 1 - 5mH inductor, Resistors: 1k, 1.2k, 4.7k, and 22k ohm, 1 - VOM, 1 - Oscilloscope.

STANDARD OF PERFORMANCE: Circuit construction and operation should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 042

TEACHER	STUDENT
1. Have students read the Feedback Oscillators section of Chapter 15: "Oscillators" of Electricity and Electronics by Patrick and Fardo.	1. Read the assigned sections of the recommended text.
2. Discuss the operation of a feedback oscillator of the L-C type. The Hartley oscillator is widely used. Note the feedback path and the frequency determining components.	2. Diagram the circuitry of a Hartley oscillator. Point out the feedback path. Identify the frequency determining components.
3. Show the circuitry of a Colpitts oscillator on the chalkboard. Discuss the operation of the circuit. Note the feedback path and the frequency determining components.	3. Do the Colpitts oscillator activity of Chapter 15: Oscillators of Electricity and Electronics by Patrick and Fardo.
4. If time permits discuss Armstrong oscillators and crystal oscillators.	4. If parts are available have an Armstrong or crystal oscillator constructed.

EVALUATION CRITERIA: Circuit construction techniques and instrument use should be measured on a test with 70% accuracy.

* ELECTRONIC OSCILLATORS

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-043. Construct an astable multivibrator oscillator with an NE555 timer.

EQUIPMENT AND SUPPLIES: 1 - LM555, 2 - 33k ohm - 1/4 watt resistors, 1 - 200k ohm - 1/4 watt resistor, 1 - 0.01uF-50V capacitor, 1 - 50uF-50V capacitor, 1 - VOM, 1 - Oscilloscope.

STANDARD OF PERFORMANCE: Circuit construction, operation, explanation, and instrument use should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	

ACTIVITIES 043

TEACHER	STUDENT
*1. Have students read the IC Waveform Generators, and IC Astable Multivibrator sections of Chapter 15: "Oscillators" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the internal circuitry of an LM555 IC. Diagram the circuit on a chalkboard. Describe the functional operation of the internal parts. Show how the internal circuitry permits this IC to be used as an astable multivibrator.	*2. Do the 555 Astable Multivibrator activity of Chapter 15: "Oscillators" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Circuit construction accuracy and instrument use should be measured on a written test with 70% accuracy.

PERFORMANCE OBJECTIVE (1 Day)

TASK/COMPETENCY: AES-044. Communicate with a person by sound, graphic symbols, and light. Discuss the limitations of each method.

EQUIPMENT AND SUPPLIES: 1 - flashlight, 1 mirror.

STANDARD OF PERFORMANCE: The process of communicating with another person should be made with 100% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 044

TEACHER	STUDENT
1. Have students read the Introduction, Important Terms, and Systems sections of Chapter 16 "Communication Systems" of Electricity and Electronics by Patrick and Fardo.	1. Read the assigned sections of the recommended text.
2. Discuss communication processes. Point out the function of coding and decoding. Indicate how a coded message can be achieved by light. Use the Morse code.	2. Have groups of students communicate with each other by light. What are some limitations of light communication?
3. Discuss communication by graphics.	3. Have groups communicate by graphics with each other. What are some limitations of graphic communication?
4. Discuss communication by sound.	4. Have groups communicate by sound. What are some limitations of sound communication?
5. Discuss some other communication processes. For example: reflection of a mirror, drums, smoke-signals, etc.	5. Communicate with a group by some other process.

* COMMUNICATION ELECTRONIC SYSTEM ANALYSIS

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-045. Examine a CW communication and send coded messages.

EQUIPMENT AND SUPPLIES: Teacher demonstration transmitter and CW receiver.

STANDARD OF PERFORMANCE: CW communication should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Single-stage CW transmitter Fig. 16-8 of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo. 1 - Communications receiver that will detect CW signals. 1 - Oscilloscope.

ACTIVITIES 045

TEACHER	STUDENT
*1. Have students read the Electromagnetic Waves, and Continuous-Wave Communication sections of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the CW communication system by block diagram. Point out the function of the transmitter. Note how the transmitter is keyed. Indicate some representative CW signal frequencies. Point out the function of the receiver. Discuss the BFO function.	*2. Note the functions of a CW communication system.
*3. Demonstrate the operation of a CW transmitter and receiver.	*3. The transmitter of a CW system is a sinewave oscillator. Explain how an oscillator generates a sinewave. What are some representative CW frequencies?
*4. Key the transmitter and tune in the signal on a communication receiver. Show the signal developed by the BFO in operation.	*4. Explain why an RF signal that is keyed with a code requires a special type of receiver.
	5. Explain what is meant by BFO signal detection.

EVALUATION CRITERIA: Explain how CW communication is achieved by written explanation with 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-046. Determine what it takes to communicate sound or voice over wires.

EQUIPMENT AND SUPPLIES: 1 - Telephone, 1 - Speaker, 1 - DC voltage source, 1 - AC voltage source.

STANDARD OF PERFORMANCE: Written explanation of how sound is transmitted over wires.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, telephone, microphone, speakers, audio signal generator.

ACTIVITIES 046

TEACHER	STUDENT
1. Have students read the Speakers, Input Transducers, and Microphones sections of Chapter 14: "Amplifying Systems" of Electricity and Electronics by Patrick and Fardo. 2. Discuss audio frequency. Show waves, range of human hearing, and transducers. 3. Demonstrate the operation of a telephone system. Show a diagram of the microphone/earphone circuit. Point out how sound is used to generate AF electricity with a speaker. Connect an oscilloscope to the output of a microphone. Show how an earphone functions as a transducer.	1. Read the assigned sections of the recommended text. 2. Prepare a paper explaining how sound can be sent over wires. 3. Explain the limitations of communication over wires. 4. Disassemble a telephone to see the earphone and microphone.

EVALUATION CRITERIA: Explain how sound is transmitted over wires by written explanation with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-047. Investigate the principles of a radio communication system.

EQUIPMENT AND SUPPLIES: 1 - J.W. Miller #2004 antenna coil, 1 - 365pF tuning capacitor, IN34A diode, 1 - 0.001uF at 50V, 1 - earphone, 1 - long wire outside antenna.

STANDARD OF PERFORMANCE: The basic characteristics of radio communicatio should be described with 70% accuracy.

ENABLING OBJECTIVE

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - AM signal generator, 1 - oscilloscope.

ACTIVITIES 047

TEACHER	STUDENT
*1. Have students read the Amplitude Modulation Communication section of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned section of the recommended text.
*2. Discuss AM communication systems. Point out the principles of electromagnetic signal radiation, RF signal generation, modulation, AF signals, and sideband frequencies.	*2. Prepare a block diagram of an AM communication showing the transmitter and receiver. Explain how an AF signal can be mixed with RF to produce AM.
*3. Demonstrate AM signal components on an oscilloscope. Show RF, AF, and AM. Explain why modulation is needed to transmit an AF component over RF.	3. Draw some representative waveforms showing RF, AF, and AM signals.
4. Explain what is needed to receive an AM signal and produce sound.	*4. Do the AM crystal Radio Receiver activity of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Communication principles should be explained on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-048. Construct an AM transmitter and send messages.

EQUIPMENT AND SUPPLIES: 2 - 2N3644 transistors, 1 - 220uH inductor, 1 - 110-580pF variable capacitor, capacitors: 2 - 1.0uF-50V, 1 - 0.01uF at 1kV, 1 - 0.002uF at 1kV, 1 - 0.001uF at 1kV, resistors all 1/2 watt: 1 - 68 ohm, 1 - 220 ohm, 1 - 4.7k ohm, 2 - 10k ohm, 1 - 1M ohm, 1 - crystal microphone, 1 - SPST switch, 1 - 9V DC source, 1 - dummy antenna, 1 - VOM.

STANDARD OF PERFORMANCE: AM transmitter construction, instrument use, and circuit operation should be done with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Communications receiver for AM, 1 - Oscilloscope, 1 - AM transmitter demonstration circuit.

ACTIVITIES 048

TEACHER	STUDENT
1. Have students read the AM Communication System and AM Transmitters sections of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.	1. Read the assigned sections of the recommended text.
2. Discuss the circuitry of an AM transmitter as shown in the recommended text.	2. Study the circuitry of an AM transmitter.
3. Demonstrate the operation of an AM transmitter. Show the influence of loading. Tune in the signal on an AM receiver.	3. If the parts are available, do the AM Transmitter activity of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.
4. Transmit a signal over the air.	

EVALUATION CRITERIA: The principles of AM communication should be explained on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 5 Days)

TASK/COMPETENCY: AES-049. Construct an FM wireless microphone and send messages.

EQUIPMENT AND SUPPLIES: 2 - 2N3644 transistors, 2 - 1uF-12V capacitors, 2 - 0.001uF-1kV capacitors, 6.8pF-1kV capacitor, 1 - 7-60pF variable capacitor ARCO 404, 12" of #19 AWG wire, 1 - crystal microphone, resistors all 1/2 watt, 10%: 2 - 10k ohm, 1 - 4.7k ohm, 1 - 470 ohm, 1 - 68 ohm, 9V DC.

STANDARD OF PERFORMANCE: Construct an FM transmitter, use it to send messages, and examine its circuitry with 70% accuracy.

ENABLING OBJECTIVE

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - FM receiver, 1 - Oscilloscope, 1 - FM demonstration circuit.

ACTIVITIES 049

TEACHER	STUDENT
1. Have students read the FM Communication section of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo. 2. Discuss the circuitry of an FM transmitter as shown in the recommended text. 3. Demonstrate the operation of an FM transmitter. 4. Discuss printed circuit board construction. Show the layout of a board. 5. Demonstrate the winding of a tapped coil.	1. Read the assigned sections of the recommended text. 2. Study the circuitry of an FM transmitter. 3. If the parts are available, do the "FM Wireless Microphone" activity of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: The basic principles of FM communication should be explained on a written test with at least 70% accuracy.

* COMMUNICATION ELECTRONIC SYSTEM ANALYSIS

INTRODUCTION:

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-050. Investigate the principles of television and examine the circuitry of a TV receiver.

EQUIPMENT AND SUPPLIES: None - only demonstration equipment. See instructional materials.

STANDARD OF PERFORMANCE: TV communication system block diagram formation. should be done with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Operating monochrome TV receiver, 1 - Operating color TV receiver, 1 - Oscilloscope, 1 - VOM. 1 - TV signal source or antenna.

ACTIVITIES 050

TEACHER	STUDENT
*1. Have students read the Television Communication section of Chapter 16: "Communication Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the block diagram of a TV communication system as shown in the recommended text. Point out the primary function of each block.	*2. Draw a block diagram of the transmitter and receiver of a TV communication system. Write a brief explanation of the function of each block.
*3. Discuss the picture signal of a TV system. Show how it is used to modulate the AM signal.	*3. Draw some representative picture signals. Define scanning, synchronization, vertical and horizontal sweep.
*4. Demonstrate the operation of a monochrome TV receiver. Show a block diagram of the circuit.	*4. Draw a block diagram of a monochrome TV receiver.
*5. Demonstrate the operation of a color TV receiver. Point out the sections of the receiver that achieve specific functions.	*5. Draw a block diagram of a color TV receiver. Explain the function of each block.

EVALUATION CRITERIA: The basic principles of TV communication should be explained on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 Day)

TASK/COMPETENCY: AES-051. Discuss the differences between analog and digital systems.

STANDARD OF PERFORMANCE: Distinguish between analog and digital systems and define terms with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - AC signal generator, 1 Oscilloscope, 1 - VOM, Square wave generator or DC voltage source.

ACTIVITIES 051

TEACHER	STUDENT
1. Have students read the Digital Systems and System Operational States sections of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo. 2. Discuss analog and digital signals. Demonstrate the electrical differences in analog and digital signals. Show positve and negative logic values on an oscilloscope or VOM. Point out that a digital signal has only two values or levels. Analog signals can have many values. Show analog values on an oscilloscope.	1. Read the assigned sections of the recommended text. 2. Define analog, digital positive logic, negative logic, binary, digital and base.

EVALUATION CRITERIA: Explain the differences between digital and analog systems and define terms on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-052. Investigate different numbering systems.

STANDARD OF PERFORMANCE: Basic number conversions should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 052

TEACHER	STUDENT
*1. Have students read the Decimal Numbering Systems and Binary Numbering System sections of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the place value concept of decimal numbering systems. Point out the radix or base of a system. Show how the place value can be expressed as a power of the base.	*2. Define place value, base or radix, power of the base, and decimal value.
*3. Discuss the binary numbering system. Point out the base of the system, place value, and some representative number values. Show how to convert a binary number to a decimal number. Convert a decimal number to a binary number.	*3. Convert binary numbers to decimal values and decimal values to binary numbers.

EVALUATION CRITERIA: Number conversions should be made on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-053. Examine AND, OR, NOT, NAND, and NOR logic gates and determine the unique differences.

EQUIPMENT AND SUPPLIES: 1 - 6.3V AC source, 2 - SPST switches, 1 - 68 ohm 1 watt resistor, 1 - #46 or #47 lamp, 1 - SN7400, 1 - SN7432, 1 SN7410, 1 SN7402, 3 - 390 ohm 1/4 watt resistor, 3 - LED's, 1 - 5V DC source, 2 - SPDT switches.

STANDARD OF PERFORMANCE: Identify basic gate symbols with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 053

TEACHER	STUDENT
*1. Have students read the Binary Logic Functions and Gate Circuits sections of Chapter 17: "Digital Logic Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the operation of AND, OR, NOT, NOR, and NAND gates. Show that an "on" switch and lamp refers to the "1" state. The alternate zero or "0" state is represented by an off switch and an off lamp. Show the symbol for each logic gate.	2. Do the Switch-Lamp Gates activity of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.
*3. Develop a truth table for each logic gate. Show the possible alternatives for a two switch or input circuit.	*3. Take logic symbol quiz.
4. Show how logic gates are housed in IC's. Display some representative TTL gates.	*4. Draw the pin out for SN7400, SN7404, SN7408, and SN7402.
	*5. Do Activity 10-2: "IC Logic Gate Analysis" of Chapter 10: Digital Electronic Systems of Industrial Electronics Devices and Systems by Patrick and Fardo.

EVALUATION CRITERIA: Logic gate symbols and definitions should be explained on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-054. Examine the operation of clocks, RS, RST, and JK flip-flops.

EQUIPMENT AND SUPPLIES: 1 - SN7402, 1 - SN74107, 4 - LED's, 4 - 390 ohm 1/4 watt resistors, 2 - SPDT switches, 1 - SPST switch, 1 - 5V DC source, 1 - circuit construction board.

STANDARD OF PERFORMANCE: Identify flip-flops and truth tables with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

SELECTED INSTRUCTIONAL MATERIALS:

Same as the equipment and supplies list.

ACTIVITIES 054

TEACHER	STUDENT
*1. Have students read the Timing and Storage Elements and Flip-Flops sectiohs of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Demonstrate the operation of the logic gate test circuit of Fig. 17-27 of Electricity and Electronics by Patrick and Fardo.	2. Do the R-S Flip-Flop activity of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.
3. Discuss R-S flip-flops. Show how the flip-flop is set and reset. Point out uses of the circuit.	*3. Do the J-K Flip-Flop activity of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.
*4. Discuss J-K flip-flops. Show the different states of operation. Develop a truth table. Define the function of J, K, clock, clear and preclear.	

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-055. Evaluate the operation of counters, registers, decoders, and drivers.

EQUIPMENT AND SUPPLIES: 1 - DM7490, 1 - DM7493, 4 - 390 ohm - 1/4 watt resistors, 4 - LED's, 1 - 5V DC power supply, 1 - square wave signal source.

STANDARD OF PERFORMANCE: Identify symbols and explain the operation of a counter, register, decoder, and driver with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

ACTIVITIES 055

TEACHER	STUDENT
*1. Have students read the Flip-Flops, Decode Counters, and Decoding sections of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
2. Review the function of a flip-flop. The toggling function of a J-K flip-flop is quite important. Show how this function is used to achieve a shift register.	2. Observe the operation of a J-K flip-flop as a shift register.
*3. Demonstrate a shift register circuit. Show how it shifts up and down.	*3. Do the Four-Bit Binary Counter activity of Chapter 17: "Digital Electronic Systems of Electricity and Electronics by Patrick and Fardo.
*4. Discuss the flip-flop as a binary counter. Point out how IC's are used to achieve binary and BCD counting.	*4. Do the BCD counter activity of Chapter 17: "Digital Electronic Systems of Electricity and Electronics by Patrick and Fardo.
*5. Discuss the need for decoding and driving. Show some IC decoder-driver chips.	

EVALUATION CRITERIA: Symbol identification, IC pin-out, and circuit construction should be explained on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-056. Evaluate the operation of single number and seven-segment displays.

EQUIPMENT AND SUPPLIES: 1 - MAN - Seven Segment LED display, 8 - 390 ohm 1/4 watt resistors, 1 - 5V DC power supply, 1 - VOM.

STANDARD OF PERFORMANCE: The operation of display devices should be examined with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 056

TEACHER	STUDENT
1. Have students read the Digital System Displays section of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.	1. Read the assigned section of the recommended text.
2. Demonstrate the operation of a single numerial display. A "Nixie" tube is widely used for this operation. Discuss gas ionization, ionization potentional, and construction.	2. Observe the operation of a single number display.
3. Discuss the seven-segment display. Point out the unique construction, operational voltage, and I-V characteristics.	3. Do the Seven-Segment Display activity of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.

* DIGITAL ELECTRONIC SYSTEMS

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-057. Investigate the fundamental components of different digital systems.

EQUIPMENT AND SUPPLIES: None or optional according to selected activities.

STANDARD OF PERFORMANCE: Digital system diagrams and symbol identification should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

ACTIVITIES 057

TEACHER	STUDENT
*1. Have students read the Digital Counting Systems and Computer sections of Chapter 17: "Digital Electronic Systems" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Demonstrate the operation of a counting timer.	*2. Do the "Counting Timer" activity of Electricity and Electronics by Patrick and Fardo, if the parts are available.
*3. Discuss the operation of a computer from a block diagram approach. Point out the function of each block.	3. Diagram the functional blocks of a computer.
4. Discuss microprocessor chips. Show the block functions of this chip.	

EVALUATION CRITERIA: Digital system diagrams, components, and symbols should be identified and defined on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-058. Analyze an electronic power control system and its fundamental parts.

STANDARD OF PERFORMANCE: The fundamental parts of an electronic power control system should be identified with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended	1. Recommended
a. *Electricity and Electronics* Patrick and Fardo.	a. *Electricity and Electronics* Patrick and Fardo.
2. Suggested	
a. *Electricity and Electronics* Gerrish and Dugger.	
b. *Understanding Electronic Systems* by Fardo and Patrick.	
c. *Industrial Electronics Devices and Systems* by Patrick and Fardo.	

ACTIVITIES 058

TEACHER	STUDENT
1. Have students read the Introduction, Important Terms, Electronic Power Control System sections of Chapter 18: "Electronic Power Control of *Electricity and Electronics* by Patrick and Fardo.	1. Read the assigned sections of the recommended text.
2. Discuss electrical power control. Work some problems showing the influence of resistance as a power control element. Point out the low efficiency of this power control procedure.	2. Observe the symbols of devices used to control electrical power.
3. Discuss voltage changes as a power control procedure. Indicate the low efficiency of this process and the high cost of the control element.	3. Work some problems showing how resistance is used to control power.
4. Show how switching can be used to achieve power control. Point out its high level of efficiency. Show how an SCR can be made to respond as a switch.	4. Observe the efficiency of power control by resistance, voltage, and switching. Explain why switching is a high efficiency power control procedure.

EVALUATION CRITERIA: Electronic power system parts should be identified and defined on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-059. Test an SCR, identify its leads, and analyze its characteristics.

EQUIPMENT AND SUPPLIES: 1 - General Electric C - 122D SCR, 1 - VOM, 1 Assortment of damaged SCR's and other types.

STANDARD OF PERFORMANCE: The condition status, lead identification, and operating characteristics of an SCR should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 059

TEACHER	STUDENT
*1. Have the students read the Silicon Controlled Rectifiers section of Chapter 18: "Electronic Power Control," of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned section of the recommended text.
*2. Discuss the crystal construction of an SCR. Show its symbol and the polarity of the crystal material attached to each element. Point out how triggering is achieved using the two transistor analogy.	*2. Draw a symbol for the SCR. Identify the gate, anode, and cathode. Show the polarity of the crystal material attached to each electrode.
*3. Discuss the operation of an SCR. Point out the unique characteristics of this device. Show how the VBO can be altered by value changes in IG.	*3. Make a drawing of the I-V characteristics of an SCR. Show where VBO, IAK, and PRV are located. Note how a change in IG alters the VBO.
4. Demonstrate how the VOM is used to test an SCR. Note that there must be sufficient holding current from the VOM to cause an SCR to latch.	4. Do the SCR Testing with a VOM activity of Chapter 18: "Electronic Power Control" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Lead identification, the operational status, fundamental characteristics, and element names of an SCR should be identified and defined on a written test with 70% accuracy.

* ELECTRONIC POWER CONTROL SYSTEMS

PERFORMANCE OBJECTIVE (4 - 7 Days)

TASK/COMPETENCY: AES-060. Construct SCR power control circuits with AC and DC.

EQUIPMENT AND SUPPLIES: 1 - 6V DC power source, 1 - 6V AC source, 1 - 1.5V dry cell, 2 - C - 122D SCR's, 2 - IN4004 diodes, 1 - 10uF-50V capacitor, 1 - 0.1uF-50V capacitor, 2 - 1k ohm 1/4 watt resistors, 1 - 270 ohm 1/4 watt resistor, 1 - 500k ohm potentiometer, 1 - #47 or #46 lamp, 2 - SPST toggle switches, 2 - NO push buttons.

STANDARD OF PERFORMANCE: AC and DC SCR power control circuit construction, instrument use, and evaluation procedures should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, 1 - AC phase-shifter circuit, 1 - AC power control circuit with an SCR.

ACTIVITIES 060

TEACHER	STUDENT
*1. Have students read the DC Power Control with SCR's and AC Power Control with SCR's sections of Chapter 18: "Electronic Power Control" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the operation of an SCR to control DC power. Point out the latching problem. Explain how a conductive SCR can be turned off.	*2. Do the DC Power Control Switch activity of Chapter 18: "Electric Power Control" of Electricity and Electronics by Patrick and Fardo.
*3. Discuss the operation of an SCR as an AC power control device. Point out that AC has automatic communication. Show that an SCR controls power for one alternation.	3. Do the DC Start-Stop Power Control activity of Chapter 18: "Electric Power Control, of Electricity and Electronics by Patrick and Fardo.
4. Demonstrate AC phase shifting and show the waveforms of an AC power control circuit using an SCR.	*4. Do the Static AC Power Control with an SCR activity of Chapter 18: "Electrical Power Control" of Electricity and Electronics by Patrick and Fardo.
	5. Do the AC Phase Control of an SCR activity of Chapter 18: "Electrical Power Control" of Electricity and Electronics by Patrick and Fardo.

EVALUATION CRITERIA: The fundamental principles of SCR power control should be explained and defined on a written test with at least 70% accuracy.

PERFORMANCE OBJECTIVE (2 - 4 Days)

TASK/COMPETENCY: AES-061. Test a triac, identify its leads, and analyze its characteristics.

EQUIPMENT AND SUPPLIES: 1 - General Electric SC - 142D triac, 1 - VOM, 1 - Assortment of faulty triacs and other types.

STANDARD OF PERFORMANCE: Triac testing, lead identification, and characteristic analysis should be made with 70% accuracy.

ENABLING OBJECTIVE

REFERENCES

TEACHER	STUDENT
1. Recommended	1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

ACTIVITIES 061

TEACHER	STUDENT
*1. Have students read the Triac Power Control, Triac Operation, and Triac I-V characteristic sections of Chapter 18: "Electronic Power Control" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text.
*2. Discuss the crystal construction of a triac. Show its symbol and the polarity of the crystal material attached to each element. Point out the dual polarity of material attached to each element.	*2. Draw a symbol for the triac. Identify the gate, T1, and T2. Show the dual polarity of each electrode.
*3. Discuss the operation of a triac. Show its I-V characteristics. Point out the unique characteristics of a triac. Show how the VBO can be altered with IG.	*3. Make a drawing of the I-V characteristics of a triac. Show the VBO, IT, IH, and IG for each polarity.
*4. Demonstrate how the VOM is used to test a triac. Note that there must be sufficient holding current from the VOM to cause the triac to latch.	*4. Do the Triac Testing activity of Chapter 18: "Electronic Power Control" of Electronic Power Electronics by Patrick and Fardo.

EVALUATION CRITERIA: Lead identification, the operational status, fundamental characteristics, and element names of a triac should be made on a written test with 70% accuracy.

* ELECTRONIC POWER CONTROL SYSTEMS

PERFORMANCE OBJECTIVE (3 - 7 Days)

TASK/COMPETENCY: AES-062. Build a triac AC power control circuit.

EQUIPMENT AND SUPPLIES: 1 - SC-142D triac, 1 - ST-2 diac, 1 - 6V AC source, 2 - 470 ohm 1/4 watt resistors, 1 - 68k ohm 1/4 watt resistor, 2 - 0.1uF-200V capacitors, 1 - 1.0uF-100V capacitor, 2 - NO push buttons, 1 - SPST switch, 1 - #46 or #47 lamp, 1 - 100k ohm potentiometer, 1 500k ohm potentiometer.

STANDARD OF PERFORMANCE: Triac circuit construction, device evaluation, and instrument use should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended a. Electricity and Electronics Patrick and Fardo. *2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	*1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, 1 - AC power control circuit with triac.

ACTIVITIES 062

TEACHER	STUDENT
*1. Have students read the Triac Applications, Diac Power Control, and Electronic Power Control Considerations sections of Chapter 18: "Electronic Power Control" of Electricity and Electronics by Patrick and Fardo.	*1. Read the assigned sections of the recommended text. *2. Do the Start-Stop Triac Control activity of Chapter 18: "Electronic Power Control."
*2. Discuss the triac as a static switch. Point out the limitations of this circuit.	*3. Do the AC Variable Lamp Control activity of Chapter 18.
3. Discuss the Start-Stop Triac Control Circuit. Show how the circuit is triggered and turned off. Point out how conduction is maintained.	4. Do the Basic Phase-Shifter Triac Triac Control of Chapter 18. 5. Do the Two-Stage Phase-Shifter Triac Control Circuit of Chapter 18.
4. Demonstrate how a triac is used to achieve variable power control. Explain how the gate current is varied.	
5. Explain how phase-shifting is used to control the conduction of a triac.	
6. Demonstrate the characteristcs of a diac.	
*7. Demonstrate the Motor Speed Control activity of Chapter 18.	

EVALUATION CRITERIA: Triac circuit operation should be explained on a written test with at least 70% accuracy.

ELECTRONIC SYSTEM TRANSDUCERS

PERFORMANCE OBJECTIVE (1 - 2 Days)

TASK/COMPETENCY: AES-063. Define the term transducer and discuss the differences between active and passive devices.

STANDARD OF PERFORMANCE: Active and passive device definitions and symbol identification should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended	1. Recommended
a. Industrial Electronics: Devices and Systems by Patrick and Fardo.	a. Industrial Electronics: Devices and Systems by Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - VOM, Several active and passive transducers.

ACTIVITIES 063

TEACHER	STUDENT
1. Have students read the Transducer Types, Active Transducers, and Passive Transducers sections of Chapter 6: Electronic Transducers sections of Chapter 6: Electronic Transducers of Industrial Electronics: Devices and Systems by Patrick and Fardo.	1. Read the assigned sections of the reference material.
2. Discuss the term transducer. Give some examples of transducers.	2. Explain what is meant by the term transducer.
3. Define active and passive transducers.	3. List some examples of common transducers.
4. Demonstrate the operation of an active transducer.	4. Observe the operation of an active transducer.
5. Demonstrate the operation of a passive transducer.	5. Observe the operation of a passive transducer.

EVALUATION CRITERIA: Explain the difference between active and passive transducers on a written test with at least 70% accuracy.

ELECTRONIC SYSTEM TRANSDUCERS

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-064. Examine the functional characteristics of active transducers that respond to light, heat, sound, and electromagnetic energy.

EQUIPMENT AND SUPPLIES: 1 - Thermocouple, 1 - Photovoltaic cell, 1 - Piezoelectric transducer, Magnet wire, 1 - VOM.

STANDARD OF PERFORMANCE: The characteristics of active transducers should be identified and defined with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended	1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, VOM, Hall-effect transducer, photovoltaic cell, and thermocouple.

ACTIVITIES 064

TEACHER	STUDENT
1. Have students read the Electromechanical Transducers, Hall-effect Transducers, Photovoltaic Transducers, Piezoelectric Transducers, and Thermocouple sections of Industrial Electronics: Devices and Systems by Patrick and Fardo.	1. Read the assigned sections of the reference material.
2. Demonstrate the operation of an electromechanical transducer.	2. Do activity 6-1: Electromagnetic Transducers of Chapter 6: Electronic Transducers of Industrial Electronics: Devices and Systems by Patrick and Fardo.
3. Demonstrate the Hall-effect Transducer.	3. Note the operation of a Hall-effect transducer. Write a brief explanation of how the Hall-effect principle is used as a transducer.
4. Demonstrate the operation of a photovoltaic transducer.	4. Do activity 6-2: Photovoltaic Cell Transducers of Industrial Electronics: Devices and Systems by Patrick and Fardo.
5. Explain the piezoelectric effect and show how it can be used as a transducer.	5. Do activity 6-3: Piezoelectric Transducers of Industrial Electronics: Devices and Systems by Patrick and Fardo.
6. Demonstrate the operation of a thermocouple.	

ELECTRONIC SYSTEM TRANSDUCERS

PERFORMANCE OBJECTIVE (1 - 3 Days)

TASK/COMPETENCY: AES-065. Examine the functional characteristics of passive transducers that respond to light, heat and sound.

EQUIPMENT AND SUPPLIES: 1 - Light dependent resistor, 1 - Thermistor, 1 - VOM.

STANDARD OF PERFORMANCE: The characteristics of passive transducers should be identified and defined with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, 1 - Omegafilm RTD type 100-P30.

ACTIVITIES 065

TEACHER	STUDENT
1. Have students read the Thermoresistive Transducers and Photoconductive Transducers sections of Chapter 6: Electronic Transducers of Industrial Electronics: Devices and Systems by Patrick and Fardo.	1. Read the assigned sections of the reference material.
2. Demonstrate the operation of a resistance temperature detector or RTD.	2. Observe activity 6-6: RTD Transducers of Industrial Electronics: Devices and Systems.
3. Discuss the operation of a thermistor.	3. Do activity 6-7: Thermistor Transducers of Chapter 6: Electronic Transducers of Industrial Electronics: Devices and Systems.
4. Discuss the light dependent resistor or LDR. Explain its construction, symbols, and characteristics.	4. Do activity 6-8: Light Dependent Resistor Transducers of Chapter 6: Electronic Transducers of Industrial Electronics: Devices and Systems.

EVALUATION CRITERIA: Passive transducer circuit operation, symbol identification, and fundamental characteristics should be explained on a written test with at least 70% accuracy.

* INDUSTRIAL PROCESS CONTROL SYSTEMS

PERFORMANCE OBJECTIVE (3 - 6 Days)

TASK/COMPETENCY: AES-066. Analyze industrial processes that respond to heat, light, liquid level, flow, number, rotational speed, electrical conductivity, or chemical changes.

EQUIPMENT AND SUPPLIES: 1 - Photoconductive cell, 1 - Bourdon pressure gauge, 1 - hygrometer, 1 - thermistor, 2 copper strips.

STANDARD OF PERFORMANCE: The fundametnal parts of an industrial process control system should be identified with 70% accuracy.

ENABLING OBJECTIVE

REFERENCES

TEACHER	STUDENT
1. Recommended a. *Electricity and Electronics* Patrick and Fardo. 2. Suggested a. *Electricity and Electronics* Gerrish and Dugger. b. *Understanding Electronic Systems* by Fardo and Patrick. c. *Industrial Electronics Devices and Systems* by Patrick and Fardo.	1. Recommended a. *Electricity and Electronics* Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Photoconductive cell, 1 - Bourdon pressure gauge structure, 1 - hygrometer with wet and dry bulb thermometers, 1 - thermistor, 2 - copper strips and a glass container, 1 - VOM, 1 - oscilloscope.

ACTIVITIES 066

TEACHER	STUDENT
*1. Have students read the Humidity Transducers, Pressure Transducers, Flow Transducers, Level Determination, Speed Sensing, and Vibration Transducers sections of Chapter 20: Electronic Transducers of Industrial Electronics: Devices and Systems by Patrick and Fardo.	*1. Read the assigned sections of the reference material.
*2. Discuss the operation of an industrial process control system. Point out the common features of source, path, control, load, and indicator.	*2. Write a paper explaining the common features of industrial process control systems.
*3. Discuss sensors that detect a change in humidity, pressure, flow, level, speed and vibration.	*3. Take notes about the distinguishing features of common electronic process control sensors Note the features needed to be considered in designing a process control system.
*4. Demonstrate the operation of common transducers. Show symbols, circuits, and process control operations. Point out unique features that must be considered in the operation of a system.	*4. Note the characteristic differences in transducer operation.

EVALUATION CRITERIA: The fundamental operation of different industrial process control systems should be explained with 70% accuracy.

* INDUSTRIAL PROCESS CONTROL SYSTEMS

PERFORMANCE OBJECTIVE (3 - 7 Days)

TASK/COMPETENCY: AES-067. Develop a control system that responds to any of the previous industrial processes.

EQUIPMENT AND SUPPLIES: Optional, depending on the transducer used. As a rule there should be no new components.

STANDARD OF PERFORMANCE: The operational fundamentals of the industrial process should be explained with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, 1 - VOM, Miscellaneous system control components.

ACTIVITIES 067

TEACHER	STUDENT
*1. Have students select a process to be controlled. Discuss the problems of control and the limitations that must be taken into account. The availability of parts is a primary factor.	*1. Investigate the control possibilities that can be achieved in the laboratory.
*2. Have students read about the control process in Industrial Electronics: Devices and Systems.	*2. Read selected sections of the reference source.
*3. Discuss the control procedure. Point out the limitations of the project.	*3. Note the limitations of the control procedure.
*4. Discuss the design considerations of the project.	*4. Design a circuit that will achieve control of a system.
*5. Discuss test procedures and electrical safety.	*5. Test the operation of the control circuit.
6. Show how the control parameters of the project can be evaluated.	6. Define the control parameters.

EVALUATION CRITERIA: Operation of the industrial process designed in the laboratory should be explained by a written paper with 70% accuracy.

* INDUSTRIAL PROCESS CONTROL SYSTEMS

PERFORMANCE OBJECTIVE (3 - 7 Days)

TASK/COMPETENCY: AES-068. Develop a control system for a different industrial process and demonstrate its ability to achieve control.

EQUIPMENT AND SUPPLIES: Optional depending on the transducer used. As a rule, there should be no new components.

STANDARD OF PERFORMANCE: The operation of an industrial process control system should be explained with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Oscilloscope, 1 - VOM, Miscellaneous system control components.

ACTIVITIES 068

TEACHER	STUDENT
*1. Have students select a process to be controlled. Discuss the problems of control and the limitations that must be taken into account. This control process must be different from AES.067. The availability of parts is a major consideration in project selection.	*1. Investigate the control possibilities that can be achieved in the laboratory.
*2. Have students read about the control process in Industrial Electronics: Devices and Systems by Patrick and Fardo.	*2. Read selected sections of the reference source.
*3. Discuss the control procedure being used. Point out some of the limitations.	*3. Note the limitations of the project.
*4. Discuss the design features of the project.	*4. Design a circuit that will achieve control of a system.
*5. Show how the project can be tested. Stress the electrical safety of the circuit.	*5. Test the operation of the control circuit.
*6. Explain how project control parameters can be evaluated.	*6. Define the control, parameters of the project.

EVALUATION CRITERIA: Operation of the designed industrial process control system should be explained with at least 70% accuracy.

PERFORMANCE OBJECTIVE (3 - 7 Days)

TASK/COMPETENCY: AES-069. Investigate the operation of a programmable controller and connect it; achieve three different forms of control.

EQUIPMENT AND SUPPLIES: 1 - Programmable controller unit.

STANDARD OF PERFORMANCE: The fundametnal operation of a programmable controller and its circuitry should be explained with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Programmable controller unit. Eptak 210 or equivalent.

ACTIVITIES 069

TEACHER	STUDENT
*1. Have students read Chapter 12: Programmable Controllers of Industrial Electronics: Devices and Systems by Patrick and Fardo.	*1. Read the assigned reference material.
*2. Discuss the physical makeup of a programmable controller.	*2. Diagram the physical layout of a programmable controller.
*3. Demonstrate the operation of a programmable controller.	*3. Observe the operation of a programmable controller.
*4. Discuss the programming procedure.	*4. Note the programming procedure.
5. Demonstrate how the unit is programmed.	5. Observe the programming procedure. List some of the important steps.
6. Discuss how a programmable controller can be used to achieve varying types of control.	6. Prepare an explanation of controller applications.

EVALUATION CRITERIA: An explanation of the operation of a programmable controller should be made on a written paper with 70% accuracy.

PERFORMANCE OBJECTIVE (3 - 5 Days)

TASK/COMPETENCY: AES-070. Analyze the operation of a robotic system and classify different systems.

EQUIPMENT AND SUPPLIES: 1 - Robotic System Kit.

STANDARD OF PERFORMANCE: Robotic system operation, classification, and term definitions should be made with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Robotic System Kit - "Hero 1."

ACTIVITIES 070

TEACHER	STUDENT
*1. Have students read the Development of Industrial Robotic Systems, Parts of a Robotic System, and Classification of Robotic Systems sections of Chapter 13: Industrial Robotic Systems of Industrial Electronics: Devices and Systems by Patrick and Fardo.	*1. Read the assigned sections of the reference source.
*2. Explain the difference between industrial robots and creature simulated robots.	*2. Prepare a written report about robotic systems. Point out the parts and different types of systems.
*3. Discuss the parts of a robotic system.	*3. Note the fundamental parts of a robotic system. Show how they are connected to form an operational system.
*4. Explain the difference between open-loop and closed-loop systems.	*4. Evaluate different system supplies.
*5. Define the term intelligent robot.	*5. Investigate different power supply types. Explain the fundamental differences.
*6. Discuss power supplies. Explain the differences between electric, hydraulic, and pneumatic supplies.	

EVALUATION CRITERIA: Robotic system operation, parts, and classifications should be explained on a written report with 70% accuracy.

PERFORMANCE OBJECTIVE (3 - 5 Days)

TASK/COMPETENCY: AES-071. Investigate the manipulator, controller, and power source of a robotic system.

EQUIPMENT AND SUPPLIES: 1 - Heath Robot System Kit.

STANDARD OF PERFORMANCE: Explain the operation of the manipulator, controller, and power source with 70% accuracy.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo. d. Robotics Course by Heathkit/ Zenith.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

SELECTED INSTRUCTIONAL MATERIALS:

1 - Heath Robotic System Kit - "Hero - 1."

ACTIVITIES 071

TEACHER	STUDENT
*1. Have students read the Classification of Robotic Systems, and Robotic System Configurations sections of Industrial Electronics: Devices and Systems by Patrick and Fardo.	*1. Read the assigned sections of the reference source.
*2. Demonstrate the operation of the manipulator.	*2. Note the differences in manipulator operation.
*3. Define robot configurations.	*3. Explain robot configurations.
*4. Discuss the differences between jointed-arm, cartesian, cylindrical, and spherical.	*4. Diagram different robot configurations.
*5. Demonstrate the response of a robot to different commands.	*5. Note the response of a robot to commands.
6. Have students read the introductory sections of the Robotics Course, by Heathkit.	6. Read the assigned sections of the reference source.

EVALUATION CRITERIA: Explain robot configurations, manipulators, controllers, and power supplies on a written test with 70% accuracy.

* ROBOTIC SYSTEMS

PERFORMANCE OBJECTIVE (3 - 5 Days)

TASK/COMPETENCY: AES-072. Examine the mechanical parts, sensors, degrees of freedom and control procedures of a robotic system.

EQUIPMENT AND SUPPLIES: 1 - Heath Robot System.

STANDARD OF PERFORMANCE: Recognize the characteristics of robot mechanical parts, sensors, degrees of freedom, and control procedures should be identified and defined with 70% accuracy.

REFERENCES

TEACHER	STUDENT
*1. Recommended	*1. Recommended
a. Electricity and Electronics Patrick and Fardo.	a. Electricity and Electronics Patrick and Fardo.
*2. Suggested	
a. Electricity and Electronics Gerrish and Dugger.	
b. Understanding Electronic Systems by Fardo and Patrick.	
c. Industrial Electronics Devices and Systems by Patrick and Fardo.	
d. Robotics Course, by Heathkit/ Zenith.	

SELECTED INSTRUCTIONAL MATERIALS:

1 - Heath Robotic System Kit - "Hero - 1."

ACTIVITIES 072

TEACHER	STUDENT
*1. Have students read the Degrees of Freedom of a Robotic System section of Industrial Electronics: Devices and Systems by Patrick and Fardo.	*1. Read the assigned section of the reference source.
*2. Demonstrate the degrees of freedom of a robot.	*2. Note the meaning of degrees of freedom.
*3. Correlate the degrees of freedom with human movements.	*3. Explain the degrees of freedom.
*4. Connect a robot and show how it responds to produce its degrees of freedom.	*4. Observe the response of a robot.
*5. Discuss the mechanical functions that can be achieved with different degrees of freedom.	*5. Note the degrees of freedom achieved by the robot.
	6. Point out the mechanical functions achieved by each degree of freedom.

EVALUATION CRITERIA: The mechanical parts, sensors, degrees of freedom, and control of a robot should be explained and defined on a written report with at least 70% accuracy.

PERFORMANCE OBJECTIVE (3 - 5 Days)

TASK/COMPETENCY: AES-073. Examine different programming procedures.

STANDARD OF PERFORMANCE: Write a program for a robot. The program must be 100% accurate to perform its operation.

REFERENCES

TEACHER	STUDENT
1. Recommended a. Electricity and Electronics Patrick and Fardo. 2. Suggested a. Electricity and Electronics Gerrish and Dugger. b. Understanding Electronic Systems by Fardo and Patrick. c. Industrial Electronics Devices and Systems by Patrick and Fardo. d. Robotics Course, by Heathkit/Zenith.	1. Recommended a. Electricity and Electronics Patrick and Fardo.

ACTIVITIES 073

TEACHER	STUDENT
1. Have students read the Programming Robotic Systems, Motions of Robotic Systems, Sensors for Robotic Systems, Mechanical Parts of Industrial Robots, and Control Systems for Industrial Robots sections of Industrial Electronics: Devices and Systems by Patrick and Fardo.	1. Read the assigned sections of the suggested reference.
2. Demonstrate manual, lead through, walk-through and software programming.	2. Observe different programming procedures.
3. Discuss software programming. Point out procedures, plans, and mapping.	3. Define software programming commands and procedures.
4. Program the demonstration robot.	4. Note the programming procedure.

EVALUATION CRITERIA: Explain programming procedures on a written report with 70% accuracy.

APPENDIX

APPENDIX A

ADVANCED ELECTRONIC SYSTEMS

Course Content

- I. Analyzing Electrical and Electronic Systems
  - A. System Functions
    - 1. Energy Sources
      - a. DC energy sources
      - b. AC energy sources
    - 2. Path
      - a. Conductors
      - b. Insulators
    - 3. Control
      - a. Full Control
      - b. Partial Control
    - 4. Loads (The Work Function)
    - 5. Indicators
      - a. Permanently Attached Indicator
      - b. Service Indicators
  - B. Analyze the Operation of a Flashlight
    - 1. Indicate the source, path, control, load, and indicator
  - C. Structure of Matter
    - 1. Electrons, Protons and Neutrons
    - 2. Laws of Attraction and Repulsion
    - 3. Static Electricity
  - D. Soldering
  - E. Electrical Safety

- II. Electrical System Components
  - A. The Flashlight
    - 1. System Components
      - a. Chemical sources of DC
        - (I). Primary Cells
        - (II). Secondary Cells
      - b. Paths
        - (I). Conductor Types
        - (II). Insulator Types
      - c. Control
        - (I). Full
          - (A). Switches
          - (B). Circuit Breakers
        - (II). Partial
          - (A). Resistors
          - (B). Potentiometers
      - d. Load
        - (I). Resistance Loads
          - (A). Lighting Effect
          - (B). Heating Effect

        e. Indicators
            (I). Light Indicators
            (II). Meters (Analog)
    B. Symbols
        1. Schematic Diagrams
    C. Resistors
        1. Identification
            a. Color Code
            b. Ohmatic Value
        2. Value Measurement
    D. Voltage
        1. Definition
        2. Measurement
    E. Current
        1. Definition
        2. Measurement

III. DG Electrical Components and Circuit Operation

    A. Ohm's Law
        1. Voltage
        2. Current
        3. Resistance
        4. Wattage
    B. Series DC Circuits
        1. Characteristics of V, I, R, W
        2. Measured Values
        3. Applications
        4. Calculated Values
    C. Parallel DC Circuits
        1. Characteristics of V, I, R, W
        2. Measured Values
        3. Applications
        4. Calculated Values
    D. Combination DC Circuits
        1. Characteristics of V, I, R, W
        2. Measured Values
        3. Applications
        4. Calculated Values

IV. Magnetism and Electromagnetism

    A. Permanent Magnetism
        1. Terms
        2. Field Structure
        3. Magnetizing Metal
        4. Demagnetizing Metal
        5. Material
        6. Strength
        7. Domain Theory
    B. Electromagnets
        1. Terms
        2. Field Structure

        3. Construction
        4. Characteristics
        5. Operational Theory

V. Sources of Electrical Energy

- A. Chemical Sources
  1. Primary Cells
  2. Secondary Cells
- B. Light Sources
- C. Heat Sources
- D. Pressure Sources
- E. Electromagnetic Induction
- F. Generating a Voltage
- G. Electrical Generator Basics
- H. Single-Phase AC Generators
- I. Three-Phase AC Generators
- J. Direct-Current Generators
  1. Permanent Magnet DC
  2. Generators
  3. Separately Excited DC
  4. Self-Excited Generators
  5. Generator Operating
  6. Characteristics

VI. AC System Components

- A. Alternating-Current Voltage
- B. Single-Phase and Three-Phase AC
- C. Measuring AC Voltage with a VOM
- D. Using an Oscilloscope
- E. Ohm's and Kirchhoff's Laws for AC Circuits
- F. Inductance
- G. Capacitance
- H. Inductive Effects in Circuits
  1. Mutual Inductance
  2. Inductors in Series and Parallel
  3. Inductive Phase
  4. Relationships
- I. Capacitive Effects in Circuits
  1. Capacitors in Series
  2. Capacitors in Parallel
- J. Leading and Lagging Currents in AC Circuits
- K. Capacitor Charging and Discharging
- L. Types of Capacitors
- M. Alternating-Current Circuits
  1. Resistive Circuits
  2. Inductive Circuits
  3. Resistive-Inductive (RL)
  4. Circuits
  5. Capacitive Circuits
  6. Resistive-Capacitive (RC)
- N. Vector Diagrams

- O. Series AC Circuits
  - 1. Series RL Circuits
  - 2. Series RC Circuits
  - 3. Series RLC Circuits
- P. Parallel AC Circuits
- Q. Power in AC Circuits
  - 1. Power in Three-Phase
  - 2. Circuits
- R. Frequency-Sensitive AC Circuits
  - 1. Filter Circuits
  - 2. Resonant Circuits
- S. Time Constant Circuits
- T. Transformers
  - 1. Transformer Operation
  - 2. Types of Transformers
  - 3. Transformer Efficiency

VII. Diode Devices

- A. Semiconductor Theory
  - 1. Atom Combinations
  - 2. Conduction in Solid Materials
  - 3. Semiconductor Materials
    - a. N-Type Material
    - b. P-Type Material
  - 4. Electron Emission
  - 5. Junction Diode
    - a. Depletion Zone
    - b. Barrier Potential
  - 6. Junction Biasing
    - a. Reverse Biasing
    - b. Forward Biasing
  - 7. Diode Characteristics
    - a. Forward Characteristic
    - b. Reverse Characteristic
    - c. Combined I-V
    - d. Characteristics
  - 8. Diode Specifications
    - a. Diode Temperature
    - b. Junction Capacitance
    - c. Switching Time
  - 9. Diode Packaging
  - 10. Diode Testing
  - 11. Semiconductor Diode Devices
    - a. Zener Diodes
    - b. Light-Emitting Diodes
    - c. Photovoltaic Cells
    - d. Photodiodes
    - e. Varactor Diodes
  - 12. Vacuum Tubes
- B. Electronic Power Supplies
  - 1. Power Supply Functions
    - a. Transformer

        b. Rectification
        c. Filtering
        d. Voltage Regulation
    2. Half Wave
    3. Full Wave
    4. Split or Divided Power Supplies

VIII. Amplification Devices

A. Bipolar Transistors
    1. Transistor Biasing
    2. NPN Transistor Biasing
    3. Transistor Beta
    4. PNP Transistor Biasing
B. Transistor Characteristics
    1. Operation Regions
    2. Characteristic Curves
C. Transistor Packaging
D. Bipolar Transistor Testing
    1. Transistor Junction Testing
    2. Lead Identification
E. Unipolar Transistors
F. Junction Field-Effect Transistors
    1. N-Channel JFET's
    2. P-Channel JFET's
    3. JFET Characteristic Curves
G. MDS Field-Effect Transistors
H. Unijunction Transistors
I. Unipolar Transistor Testing
J. Amplification Principles
    1. Reproduction and Amplification
    2. Voltage Amplification
    3. Current Amplification
    4. Power Amplification
K. Bipolar Transistor Amplifiers
L. Basic Amplifiers
    1. Signal Amplification
    2. Amplifier Bias
    3. Load-Line Analysis
    4. Linear and Nonlinear
    5. Operation
M. Classes of Amplification
N. Transistor Circuit Configurations
    1. Common-Emitter Amplifiers
    2. Common-Base Amplifiers
    3. Common-Collector
    4. Amplifiers
O. Field-Effect Transistor Amplifiers
    1. Basic FET Amplifiers
    2. Operation
    3. Dynamic JFET Amplifier
    4. Analysis
    5. MOSFET Circuit Operation

        6. FET Biasing Methods
    P. FET Circuit Configurations
    Q. Integrated-Circuit Amplifiers
        1. Operational Amplifiers
    R. Vacuum Tubes

IX. Oscillators

    A. Important Terms
    B. Oscillator Types
    C. Feedback Oscillators
        1. Oscillator Fundamentals
        2. LC Circuit Operation
        3. Armstrong Oscillator
        4. Hartley Oscillator
        5. Colpitts Oscillator
        6. Crystal Oscillator
        7. Pierce Oscillator
    D. Relaxation Oscillators
        1. RC Circuit
        2. UJT Oscillator
        3. Astable Multivibrator
        4. Monostable Multivibrator
        5. Bistable Multivibrator
        6. IC Waveform Generators
        7. IC Astable Multivibrator
        8. Blocking Oscillators

X. Communication Electronic Systems

    A. Important Terms
    B. Systems
    C. Electromagnetic Waves
    D. Continuous-Wave Communication
        1. CW Transmitter
        2. CW Receiver
    E. Amplitude Modulation
    F. Communication
        1. Percentage of Modulation
        2. AM Communication System
    G. Frequency Modulation
    H. Communication
        1. FM Communication System
    I. Television Communication
        1. Picture Signal
        2. Television Transmitter
        3. Television Receiver
        4. Color Television

XI. Digital Systems

    A. Digital Signals
        1. Binary Systems

        - 2. Octal Systems
        - 3. Hexidecimal Systems
    - B. Signal Paths
    - C. Control
        - 1. Logic Gates
        - 2. Flip-Flops
        - 3. Counting Circuits
        - 4. Decoding
        - 5. Memory
        - 6. Interfacing
    - D. Loads
        - 1. Output Devices
        - 2. Input Devices
    - E. Indicators
        - 1. Digital Instruments
        - 2. Displays

XII. Electronic Power Control

- A. Electronic Power Control Systems
    - 1. Silicon Controlled Rectifiers
    - 2. SCR Testing
    - 3. Using SCR's to Control AC and DC Power
    - 4. Triac Power Control
    - 5. Triac Testing
    - 6. Triac Power Control Circuits

XIII. Electronic System Transducers

- A. Transducer Types
    - 1. Active Transducers
        - a. Photovoltaic
        - b. Thermocouples
        - c. Piezoelectric
        - d. Chemical Energy
    - 2. Passive Transducers
        - a. Resistive
        - b. Thermistors
        - c. Light Dependent Resistor
        - d. Sound

XIV. Industrial Process Control Systems

- A. Industrial Sources
    - 1. Light Energy
    - 2. Thermal Energy
    - 3. Flow Energy Sources
    - 4. Pressure Sources
    - 5. Level Sources
    - 6. Chemical Energy Sources
- B. Paths of Industrial Processes
    - 1. Electrical Conduction
    - 2. Ducts, Pipes, and Hoses

- 3. Atmosphere or Air
- 4. Conduction, Convection, and Radiation

- C. Control
  - 1. Electronic Control Devices
    - a. Power Control Devices
      - (I). SCR's
      - (II). Triacs and Diacs
      - (III). IC Amplifiers
      - (IV). Trigger Devices
      - (V). Optoelectronic Devices
      - (VI). Thermoelectric Devices
    - b. Controllers
      - (I). Direct Control
      - (II). Programmable Controllers
- D. Industrial Process Loads
  - 1. Thermal Loads
  - 2. Light Loads
  - 3. Pressure Loads
  - 4. Flow System Loads
  - 5. Level Loading
- E. Industrial Process Indicators
  - 1. Visual Indicators
  - 2. Graphic Displays
  - 3. Chart Indicators
  - 4. Process Instrumentation

XV. Industrial Robotic Systems

- A. The Power Supply
  - 1. Electrical
  - 2. Pneumatic
  - 3. Hydraulic
- B. Controller
  - 1. Open-Loop Systems
  - 2. Closed-Loop Systems
- C. Manipulator
  - 1. Nonservo Systems
  - 2. Servo Systems
- D. Programming
  - 1. Manual
  - 2. Lead-through
  - 3. Walk-through
  - 4. Software
  - 5. Voice and Telecommunications

IMPORTANT TERMS

AC. The abbreviation used for alternating current.

Active Region. An area of transistor operation between cutoff and saturation.

Alphanumeric. A numbering system containing numbers and letters.

Alternation. Half of an AC sine wave. There is a positive alternation and a negative alternation for each AC cycle.

Ammeter. A meter used to measure current (amperes).

Ampere (symbol: I). The electrical charge movement, which is the basic unit of measurement for current flow in an electrical circuit.

Analog. Being continuous or having a continuous range of values.

Anode. A terminal of an electronic device that collects electrons.

Apparent Power (volt-amperes). The power delivered to an AC circuit; applied voltage times current.

Armature. The rotating coils of a motor which has a wound rotor.

Average Value. An AC voltage or current value based on the average of all instantaneous values for one alternation. VA = 0.637 X Vmax.

Bandwidth. The band (range) of frequencies which will pass easily through a bandpass filter or resonant circuit.

Base. A thin layer of semiconductor material between the emitter and collector of a bipolar transistor.

Barrier Potential or Voltage. The voltage that is developed across a P-N junction due to the diffusion of holes and electrons.

Battery. An electrical energy source consisting of two or more cells connected together.

Beta. A designation of transistor current gain determined by IC/IB.

Bias Forward. Voltage applied across a P-N junction that causes the conducting of majority current carriers.

Bias Reverse. Voltage applied across a P-N junction that causes little or no current flow.

Binary. A two-state or two-digit numbering system.

Binary-Coded Decimal. A code of 10 binary numbers for the decimal values from 0 to 9.

Bipolar. A type of transistor with two P-N junctions. Current carriers have two polarities, including holes and electrons.

Block Diagram. A diagram used to show how the parts of a system fit together.

Breakover Voltage. The voltage across the anode-cathode of an SCR or terminal 1 and terminal 2 of a triac that causes it to turn on.

Capacitance (C). The property of a device to oppose changes in voltage due to energy stored in its electrostatic field.

Capacitive Reactance (Xc). The opposition to the flow of AC current caused by a capacitive device (measured in ohms).

Capacitor. A device that has capacitance and is usually made of two metal plate materials separated by a dielectric material (insulator).

Carrier Wave. An RF wave to which modulation is applied.

Cathode. The terminal of an electronic device that is responsible for electron emission.

Center Frequency. The carrier wave of an FM system without modulation applied.

Center Tap. A terminal connection made to the center of a transformer winding.

Channel. The controlled conduction path of a field-effect transistor.

Circuit. A path through which electrical current flows.

Collector. A section of a bipolar transistor that collects majority current carriers.

Combination circuit. A circuit that has one portion connected in series with the voltage source and another part connected in parallel.

Commutation. The process of applying direct current of the proper polarity at the proper time to the rotor windings of a DC motor through split rings and brushes.

Component. An electrical device that is used in a circuit.

Conductor. A material that allows electrical current to flow through it easily.

Continuity Check. A test to see if a circuit is an open or closed path.

Coulomb. A unit of electrical charge that represents a large number of electrons.

Covalent Bonding. Atoms joined together by an electron-sharing process that causes a molecule to be stable.

Current. The movement of electrical charge; the flow of electrons through an electrical circuit.

Current Carriers. Electrons or holes that support current flow in solid-state devices.

Cutoff. A condition or region of transistor operation where current carriers cease to flow through the device.

Coupling. A process of connecting active components.

Cycle. A sequence of events that causes one complete pattern of alternating current from a zero reference, in a positive direction, back to zero, then in a negative direction and back to zero.

Decade Counter. A counter that achieves 10 states or discrete values.

Decoding. A digital circuit that changes coded data from one form to a different form.

Decibel. One tenth of a bel; used to express gain or loss.

Delay Time. The time that an alternation is held in an off state before it turns on.

Delta Connection. A method of connecting the stator windings of three-phase machines in which the beginning of one winding is connected to the end of the next winding; power input lines come into the junctions of the windings.

Depletion Zone. An area near the P-N junction where it is void of current carriers.

Diac. A solid-state diode device that will trigger in either direction when its breakover voltage is exceeded. A bidirectional triggering device.

Dielectric. An insulating material placed between the metal plates of a capacitor.

Difference in Potential. The voltage across two points of a circuit.

Digital. A value or quantity related to digits or discrete values.

Domain Theory. A theory of magnetism which assumes that groups of atoms produced by movement of electrons align themselves in groups called "Domains" in magnetic materials.

Dopant. An impurity added to silicon or germanium.

Drain. The output terminal of a field-effect transistor.

Dual-In-Line Package (DIP). A packaging method for integrated circuits.

Dynamic Characteristics or Operation. Electronic device operational characteristics that show how the device responds to AC or changing voltage values.

Effective Voltage (Eeff). A value of an AC sine-wave voltage which has the same heating effect as an equal value of DC voltage: Eeff = E peak X 0.707.

Efficiency. A ratio between output and input.

Electromagnet. A coil of wire wound on an iron core so that as current flows through the coil it becomes magnetized.

Electromagnetic Field. The space around an inductor that changes due to current flow through a coil. The field expands and collapses with applied AC.

Electron. A negatively charged atomic particle.

Electron Volt (eV). A measure of energy acquired by an electron passing through a potential of one volt.

Electrostatic Field. The space or area around a charged body where there is some reaction to the developed charge.

Element. The basic materials that make up all other materials; they exist by themselves (such as copper, hydrogen, carbon) or in combination with other elements (water is a combination of the elements hydrogen and oxygen).

Extrinsic. A purified material that has a controlled amount of impurity added to it when manufactured.

Emitter. A semiconductor section that is responsible for the release of majority current carriers.

Encoding. A converter that changes an input signal into binary data.

Energy. Something that is capable of producing work, such as heat, light, chemical, and mechanical action.

Feedback. Transferring voltage from the output of a circuit back to its input.

Field Coils. Electromagnetic coils that develop the magnetic fields of motors and generators.

Flip-Flop. A circuit that changes back and forth between two states.

Fluorescent Lighting. A lighting method that uses lamps which are tubes filled with mercury vapor to produce a bright white light.

Forward Bias. A voltage connection method that produces current conduction in a P-N junction.

Forward Breakover Voltage. The voltage where an SCR or triac goes into conduction in quadrant I of its I-V characteristics.

Frequency. The number of AC cycles per second, measured in Hertz (Hz).

Gate. A circuit that performs special logic operations such as AND, OR, NOT, NAND, AND NOR.

Gate. The control electrode of a triac, SCR, or FET.

Gate Current (IG). The resulting current that flows in the gate when it is forward biased.

Gauss. A unit of measurement of magnetic flux density.

Gilbert. A unit of measurement of magnetomotive force (MMF).

Henry (H). The unit of measurement of inductance which is produced when a voltage of one volt is induced when the current through a coil is changing at a rate of one ampere per second.

Hertz (Hz). The international unit of measurement of frequency equal to one cycle per second.

Holding Current (IH). A current level that must be achieved when an SCR or triac latches or holds in the conductive state.

Hole. A charge area or void where an electron is missing.

Horsepower. One horsepower (hp) - 33,000 foot-pounds of work per minute or 550 foot-pounds per second; it is the unit of measuring mechanical power; 1 hp - 746 W.

Impedance. An opposition to AC measured in ohms.

Inductance (L). The property of a circuit to oppose changes in current due to energy stored in a magnetic field.

Inductive Circuit. A circuit that has one or more inductors or has the property of inductance, such as an electric motor circuit.

Inductive Reactance (XL). The opposition to current flow in an AC circuit caused by an inductance (L), measured in ohms.

Instantaneous Voltage (Ei). A value at any instant (time) along a waveform.

Insulator. A material that offers a high resistance to electrical current flow.

Intrinsic. A semiconductor crystal in a high level of purification.

Ion. An atom that has gained or lost an electron.

Kinetic Energy. Energy that exists because of movement.

Kirchhoff's Current Law. The sum of the current flowing into any point or junction of conductors of a circuit is equal to the sum of the currents flowing away from that point.

Kirchhoff's Voltage Law. In any current loop of a circuit the sum of the voltage drops is equal to the voltage supplied to that loop; or taken with proper signs (- or +), the algebraic sum of the voltage sources and voltage drops in a circuit is equal to zero.

Latch. A holding state where an SCR or triac turns on and stays in conduction when the gate current is removed.

Light-Dependent Resistor (LDR). A photoconductive device that changes resistance with light energy.

Linear Amplifiers. Amplifying circuits that increase the amplitude of a signal that is a duplicate of the input. These devices operate in the straight-line art of the characteristic curves.

Load Line. A line drawn on a family of characteristic curves that shows how the device will respond in a circuit with a specific load resistor value.

Logic. A decision-making capability of computer circuitry.

Magnet. A metallic material, usually iron, nickel, or cobalt, which has magnetic properties.

Magnetomotive Force (MMF). A force that produces magnetic flux around a magnetic device.

Main 1 or 2. The connection points on a triac

Majority Current Carrier. Electrons of an N material and holes of a P material.

Maximum Power Transfer. A condition that exists when the resistance or impedance of a load (RL) equals that of the source which supplies it (RS).

Memory. The storage capability of a device or circuit.

Minority Current Carrier. A conduction vehicle opposite to the majority current carrier, such as holes in an N material and electrons in the P material.

Mho. Ohm spelled backward; the old unit of measurement for conductance, susceptance, and admittance; being replaced by the seimen.

Modulation. The process of changing some characteristic of an RF carrier so that intelligence can be transmitted.

Monochrome. Black-and-white television.

Monostable. A multivibrator with one stable state. It changes to the other state momentarily and then returns to its stable state.

Multifunction Meter. A meter that measures two or more electrical quantities, such as a volt-ohm-milliammeter (VOM), which measures voltage, resistance, and current.

Mutual Inductance (M). When two coils are located close together so that the magnetic flux of the coil affect one another in terms of their inductance properties.

Ohm's Law. The law that explains the relationship of voltage, current, and resistance in electrical circuits.

Ohm (Ω). The unit of measurement of electrical resistance.

Ohmmeter. A meter used to measure resistance.

Ohms Per Volt Rating (Ω/V). The rating that indicates the loading effect a meter has on a circuit when making a measurement.

Oscilloscope. An instrument that has a cathode-ray tube to allow a visual display of voltages.

Open Loop. An operation amplifier connection method that causes full or maximum amplification.

Parallel Circuit. A circuit that has two or more current paths.

Parallel Resonant Circuit. A circuit that has an inductor and capacitor connected in parallel to cause response to frequencies applied to the circuit.

Peak-To-Peak Voltage (Ep-p). The value of AC sine-wave voltage from positive peak to negative peak.

Peak Voltage (Epeak). The maximum positive or negative value of AC sine-wave voltage: Epeak = Eeff X 1.41.

Period (time). The time required to complete one AC cycle: time = 1/frequency.

Phase. A position or part of an AC wave that is compared with another wave. A wave can be in phase or out of phase with respect to another.

Piezoelectric Effect. The property of a crystal material that produces voltage by changes in shape or pressure.

Potentiometer. A variable-resistance component used as a control device in electrical circuits.

Power (P). The rate of doing work in electrical circuits, found by using the equation P= I X E.

Power Factor (PF). The ratio of power converted (true power) in an AC circuit and the power delivered (apparent power).

Q point. An operating point for an electronic device that indicates its DC or static operation with no AC signal applied.

Radio Frequency (RF). An alternating current (AC) frequency in excess of the human range of hearing which starts at 30,000 Hz.

Reactance (X). The opposition to AC current flow due to inductance (XL) or capacitance (Xc).

Rectification. The process of changing AC into pulsating DC.

Resistance. Opposition to the flow of current in an electrical circuit.

Reverse Bias. A voltage connection method producing very little or no current through a P-N junction.

Root Mean Square (RMS). Effective value of AC or 0.707 X peak value.

Schematic Diagram. A diagram used to show how the components of electrical circuits are wired together.

Scientific Notation. The use of "powers of 10" to simplify large and small numbers.

Semiconductor. A material that has a value of electrical resistance between that of a conductor and an insulator, and is used to manufacture solid-state devices such as diodes and transistors.

Series Circuit. A circuit that has one path for current flow.

Short Circuit. A circuit that forms a direct path across a voltage source so that a very high and possibly unsafe electrical current flows.

Solenoid. An electromagnetic coil with a metal core which moves when current passes through the coil.

Solid State. An area of electronics dealing with the conduction of current through semiconductors.

Source. The part of an electrical system that supplies energy to other parts of the system, such as a battery which supplies energy for a flashlight.

Switch. A control device used to turn a circuit on or off.

Symbol. Used as a simple way to represent a component.

Terminal (T1 or T2). The connecting points where load current passes through a triac. These two connection points are also called main 1 or 2.

Time Constant (RC). The period required for voltage of a capacitor to increase

63.2% of the maximum value or decrease to 36.7% of the maximum value.

Transducer. A device that changes energy from one form to another. A transducer can be on the input or output.

Triggering. The process of causing an NPNP device to switch states from off to on.

Turn-On-Time. The time of an AC waveform when an alternation occurs.

Valence Band. The part of an energy-level diagram that deals with the outermost electrons of an atom.

Valence Electrons. Electrons in the outer shell or layer of an atom.

Voltage. Electrical "pressure" that causes current to flow through a circuit.

Voltage Drop. The electrical potential (voltage) that exists across two points of an electrical circuit.

Voltmeter. A meter used to measure voltage.

Volt-Ohm-Milliammeter (VOM). A multifunction, multirange meter which usually is designed to measure voltage, current, and resistance.

Watt (W). The unit of measurement of electrical power.

Watt-Hour. A unit of energy measurement equal to one watt per hour.

Watt-Hour Meter. A meter that measures the rate of power conversion.

Wattmeter. A meter used to measure power conversion.

Wheatstone Bridge. A bridge circuit that makes precision resistance measurements by comparing an "unknown" resistance with a known or standard resistance value.

APPENDIX B

Course Objectives of Advanced Electronics

Upon completion of this course a student should:

1. Be aware of an electrical system and be able to define the role of its functional parts.
2. Have an understanding of basic electrical and electronic theory.
3. Develop basic skill in the use of electrical and electronic measuring instruments.
4. Be able to construct an electrical or electronic circuit that will accomplish a prescribed function.
5. Develop self-confidence in the use of electricity.
6. Identify and recognize safe operating procedures and construction techniques associated with electrical and electronic devices.

APPENDIX C

Laboratory Equipment

As a rule this equipment is somewhat costly per item. In some laboratories only a few pieces are needed. The recommended number is based on work stations. The number of students accommodated by a work station is optional. Ideally a work station should accommodate two students.

1 - Communications Receiver for CW Signals (1 - for the laboratory)
1 - Self made CW Transmitter (See recommended text)
Transistorized AM-FM Radio Receiver (1 for every 4 workstations)
Volt-Ohm-Milliampere Meter - Standard or Digital (1 for every 2 workstations). (Beckman TECH300), (Triplett Model 3400), (Triplett Model 60), (Simpson 260-6)
Soldering gun (1 for every 4 workstations)
Soldering Pencil (1 for every 2 workstations)
Variable DC Power Supply (1 for every workstation), (B & K Precision - Model 1601 (0-50V at 2A)
Oscilloscope - 20M Hz general purpose with probes - (1 for every 5 workstations)
Signal generator - SINE-Square, Triangle Wave, (1 for every 5 workstations)
1 - Telephone (1 for every 5 workstations)
1 - Operating Monochrome Television Receiver (1 per laboratory)
1 - Operating Color Television Receiver (1 per laboratory)
1 - Thermocouple Type J - Iron/Constantan, Omega Engineering Inc. Unsheathed fine wire IROC - 020, price per pkg. 5-$17.00
1 - Piezoelectric transducer such as a phonograph cartridge or crystal microphone

Instructional Materials

1 - Video Tape: Basic Electricity DC#E11, Circuits, Symbols and Diagrams. Bergwall Video Products Inc., P.O. Box 238, Garden City, NY 11530-0238.

1 - Video Tape Recorder/Player

1 - Television Receiver for Classroom Viewing

1 - Electrical and Electronics Symbols Chart. Graymark Instruments Inc., 3404 West Castor, Santa Ana, CA 92704.

1 - Resistor Color Code Chart (Graymark Instruments Inc.)

APPENDIX D

LABORATORY SUPPLIES

The number represents what is needed for a two-student work station.

1 - Flashlight
1 - Plastic or glass container, 10 to 16 oz.
1 - Piece of plastic wrapping paper
1 - Piece of wool cloth
1 - Piece of fur
1 - Piece of silk
1 - Pocket comb
1 - Soft steel bar, 3/4" diameter X 6" length
1 - Assortment of metal strips 1" X 6", copper, lead, tin, iron
1 - "D" type dry cell and holder
1 - 6V battery - lantern type (Eveready #731)
2 - Toggle Switches SPST
2 - Toggle Switches SPDT
1 - Set of bar magnets (two bars)
1 - Compass (Boy Scout type)
2 - Lamps (Chicago miniature lamp - type #46 or #47)
1 - Length of magnet wire - #24 AWG enamel coated - 30 ft.
1 - Length of magnet wire #18 AWG enamel coated - 30 ft.
1 - Resistor 68 ohm - 1/4 watt
1 - Resistor 100 ohm - 1 watt
1 - Resistor 220 ohm - 1 watt
8 - Resistor 390 ohm - 1/2 watt
2 - Resistor 470 ohm - 1 watt
2 - Resistor 1k ohm - 1 watt
1 - Resistor 1.2k ohm - 1/4 watt
2 - Resistor 2.2k ohm - 1/4 watt
1 - Resistor 4.7k ohm - 1/4 watt
1 - Resistor 5.6k ohm - 1/4 watt
2 - Resistor 10k ohm - 1 watt
1 - Resistor 22k ohm - 1/4 watt
2 - Resistor 33k ohm - 1/4 watt
1 - Resistor 56k ohm - 1/4 watt
1 - Resistor 68k ohm - 1/4 watt
1 - Resistor 100k ohm - 1/4 watt
1 - Resistor 200k ohm - 1/4 watt
1 - Resistor 270k ohm - 1/4 watt
1 - Resistor 1M ohm - 1/4 watt
1 - Potentiometer 25k ohm, 2 watt, linear taper
1 - Potentiometer 500k ohm, 2 watt, linear taper
4 - Diodes, IN4004, Motorola, 400 PIV-1A
1 - Diode - International Rectifier - IN34A or IN270
1 - Zener Diode, Motorola IN5346A - 9.1Vz 1 watt
1 - Zener Diode, Motorola IN5231 - 5Vz - 500M watt
1 - Junction Field Effect Transistor Motorola 2N4222
1 - MOSFET Transistor Motorola 2N3796
1 - Bipolar Transistor - General Electric 2N3397

1 - Bipolar Transistor - General Electric 2N3053
2 - Bipolar Transistors International Devices Inc. 2N3644
1 - Unijunction Transistor - General Electric 2N2647
1 - Light Dependent Resistor (C&S Cell) Clarix Co.
4 - Light Emitting Diodes, Dialight #9240, Red - 2V
1 - Photovoltaic Cell - Vactec Inc. - VTS-3014 - 0.4V at 8.4mA
1 - Photodiode - Motorola MDR 500, or equivalent
1 - Linear Integrated Circuit National LM741C
1 - Integreated Circuit Timer National LM555
1 Each - Integrated Circuit - Digital Sn7400, SN7432, SN7410, SN7402, SN74107, DM7490, DM7493
2 - Silicon Controlled Rectifiers - General Electric C-122D
1 - Triac - General Electric - SC-142D
1 - Diac - General Electric ST-2
1 - 4" Speaker 10 ohms
1 - High Impedance - Earphone
1 - Relay potter - Brumfield RS5D-6V DC 335 ohms
1 - Crystal microphone
1 - Transformer, Filament Essex/Stancor P-8384, 12.6V CT at 1A, 120V pvi
1 - AF output transformer 50 ohms to 10 ohms
2 - N-O Pushbuttons
2 - Capacitors 500uF at 50V
1 - Capacitor 50uF at 50V
2 - Capacitors 10uF at 50V
2 - Capacitors 1 uF at 100V
1 - Capacitor 6.8pF 1k V
3 - Capacitor 0.22uF at 50V
2 - Capacitor 0.1uF at 100V
1 - Capacitor 0.01uF at 1k V
2 - Capacitor 0.001uF at 1k V
1 - Capacitor 0.002uF at 1k V
1 - Capacitor - Variable 365pF
1 - Capacitor - Variable 110 to 580 pF
1 - Capacitor - Trimmer, 7 to 60pF Avco 404
1 - Inductor 4H - 50mA
1 - Inductor 25mH
1 - Inductor - 5mH
1 - Inductor - 220uH
1 - Antenna coil - J.W. Miller #2004

Selected Instructional Materials

10 - Fuses (sizes variable 1A to 5A)
1 - Fuse holder
1 - Variable DC power supply (0 to 25V at 5A)
1 - 10 ohm 5 watt resistor
1 - Isolated 120V AC source, Staco 0 to 140V at 2A - 3PNJ201V
1 - Programmable controller , Eagle Signal, Eptack 210 CP2100 processor unit with 16 point I/O track, CP2010 programmer, 120V AC input module NL110, 10-55 V DC input module NL130, NL120 output module, NL140 10-55V DC output module
1 - Robotic System - kit "Hero 1." Heath/Zenith, Benton Harbor, MI 49022

APPENDIX F

RECOMMENDED TEXTS

Patrick, Dale R. and Fardo, Stephen W. Electricity and Electronics. Englewood Cliffs, NJ. Prentice Hall, Inc., Second Ed., 1988.

Patrick, Dale R. and Fardo, Stephen W. Industrial Electronics Devices and Systems. Englewood Cliffs, NJ. Prentice Hall, Inc., 1986.

SUGGESTED REFERENCES

Gerrish, Howard H. and Dugger, William E. Electricity and Electronics. South Holland, IL. Goodheart-Wilcox, 1985.

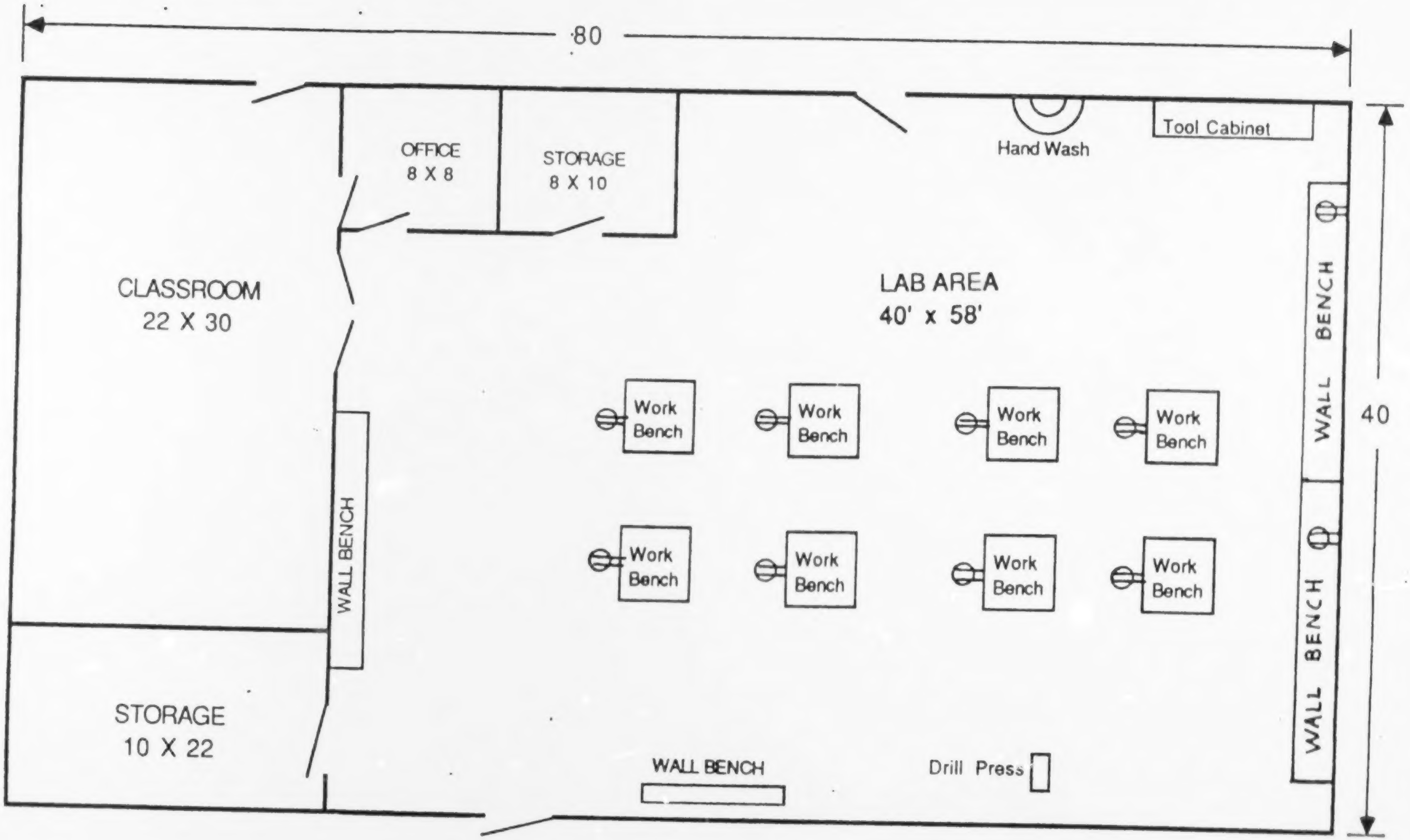
Fardo, Stephen W. and Patrick, Dale R. Understanding Electronic Systems. Englewood Cliffs, NJ. Prentice Hall, Inc., 1988.

Patrick, Dale R. and Fardo, Stephen W. Understanding Semiconductor Devices. Englewood Cliffs, NJ. Prentice Hall, Inc., 1988.

Patrick, Dale R., Electronic Instruments. Indianapolis, IN. Howard W. Sams, 3rd Ed., 1986.

Patrick, Dale R. and Fardo, Stephen W. Understanding Digital Electronic Systems. Englewood Cliffs, NJ. Prentice Hall, Inc., 1988.

Bruce, D. Modern Electronics: Basic Devices and Applications. Reston, VA. Reston Publishing Company, 1984.



Suggested Facilities Layout

APPENDIX G

FOR EXAMPLE ONLY
(For detail specifications contact Industrial Education Unit)